U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN No. 59.

B. T. GALLOWAY, *Chief of Bureau.*

PASTURE, MEADOW, AND FORAGE CROPS IN NEBRASKA.

BY

T. L. LYON,

AGRICULTURIST, NEBRASKA EXPERIMENT STATION,

AND

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ASSISTANT AGROSTOLOGIST, IN CHARGE OF COOPERATIVE EXPERIMENTS,
U. S. DEPARTMENT OF AGRICULTURE.

GRASS AND FORAGE PLANT INVESTIGATIONS.

ISSUED APRIL 29, 1904.

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1904.

BULLETINS OF THE BUREAU OF PLANT INDUSTRY.

The Bureau of Plant Industry, which was organized July 1, 1901, includes Vegetable Pathological and Physiological Investigations, Botanical Investigations and Experiments, Grass and Forage Plant Investigations, Pomological Investigations, and Experimental Gardens and Grounds, all of which were formerly separate Divisions, and also Seed and Plant Introduction and Distribution, the Arlington Experimental Farm, Tea Culture Investigations, and Domestic Sugar Investigations.

Beginning with the date of organization of the Bureau, the several series of bulletins of the various Divisions were discontinued, and all are now published as one series of the Bureau. A list of the bulletins issued in the present series follows.

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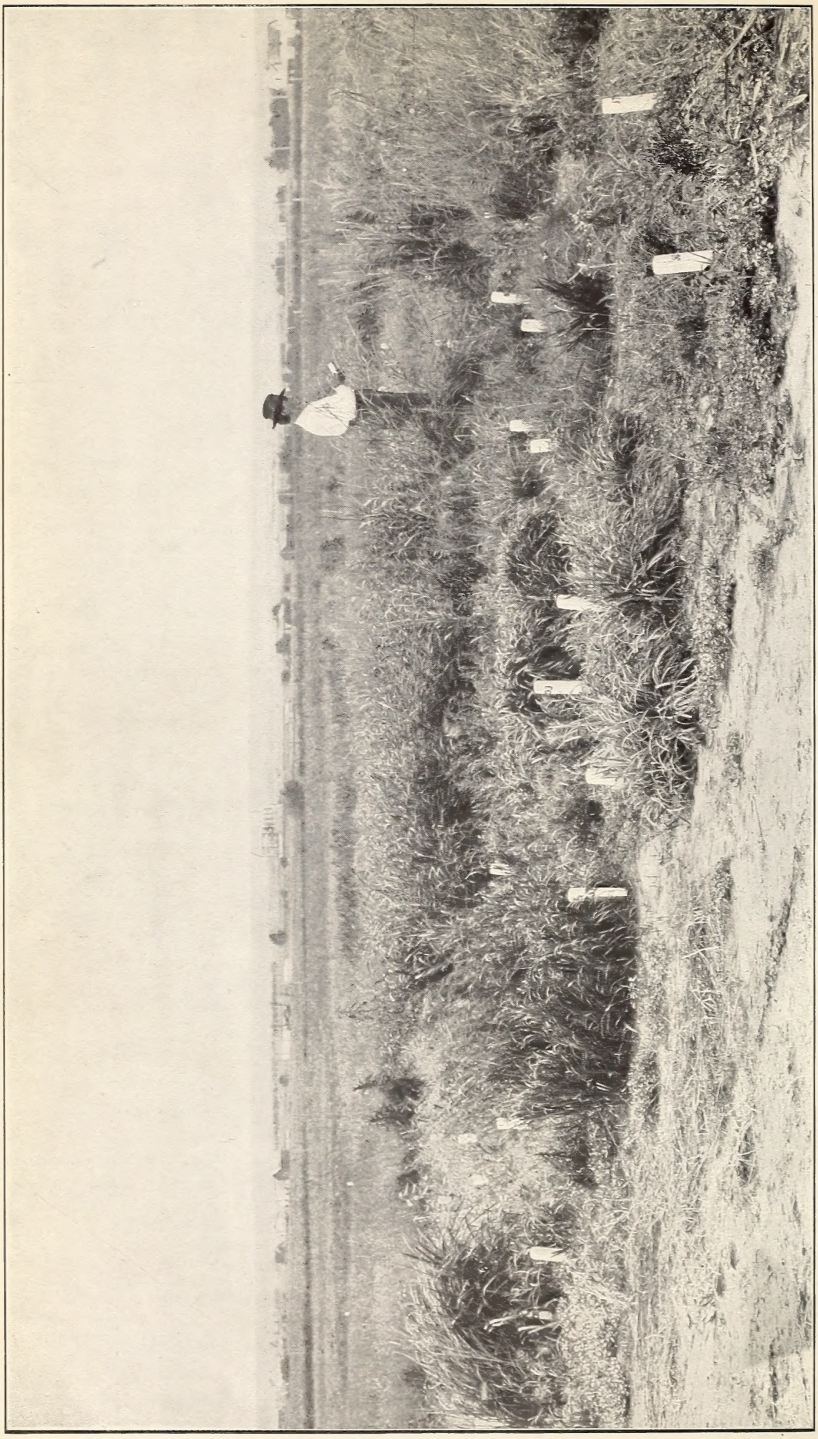

GRASS GARDEN, NEBRASKA EXPERIMENT STATION.

U. S. DEPARTMENT OF AGRICULTURE.

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BUREAU OF PLANT INDUSTRY.

BEVERLY T. GALLOWAY, *Chief.*
J. E. ROCKWELL, *Editor.*

GRASS AND FORAGE PLANT INVESTIGATIONS.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., March 4, 1904.

Sir: I have the honor to transmit herewith a paper entitled "Pasture, Meadow, and Forage Crops in Nebraska," and respectfully recommend that it be published as Bulletin No. 59 of the series of this Bureau.

This paper was prepared by Mr. T. L. Lyon, Agriculturist of the Nebraska Experiment Station, and Mr. A. S. Hitchcock, Assistant Agrostologist, in Charge of Cooperative Experiments, Grass and Forage Plant Investigations, and has been submitted by the Agrostologist with a view to publication.

The illustrations, consisting of six half-tone plates and eight text figures, are necessary to a full understanding of the text.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

PREFACE.

During the past few years a large number of tests of grasses and forage plants have been made by the Nebraska Agricultural Experiment Station in cooperation with the United States Department of Agriculture. The Department has furnished a part of the seeds for these tests, and has from time to time, at the request of the director of the station, made suggestions regarding the nature and plans of the work to be done. At the request of Prof. T. L. Lyon, Associate Director of the Station, Prof. A. S. Hitchcock, of this Office, visited the station during the past winter and prepared the following bulletin from notes made by the officers of the station. It is a matter of gratification that these notes were in such form as to render the task comparatively easy.

The present paper contains the results of the cooperative experiments and also some general information upon the forage conditions of Nebraska, in the preparation of which Professor Hitchcock has been in constant consultation with Professor Lyon.

The results of these experiments are of interest to many of the surrounding States having similar climatic conditions and in which many of the same forage plants are grown.

W. J. Spillman,
Agrostologist.

Office of the Agrostologist,
Washington, D. C., February 27, 1904.

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PASTURE, MEADOW, AND FORAGE CROPS IN NEBRASKA.

INTRODUCTION.

The value of the hay and forage crop of the United States may best be presented by reciting a few facts taken from the agricultural statis-

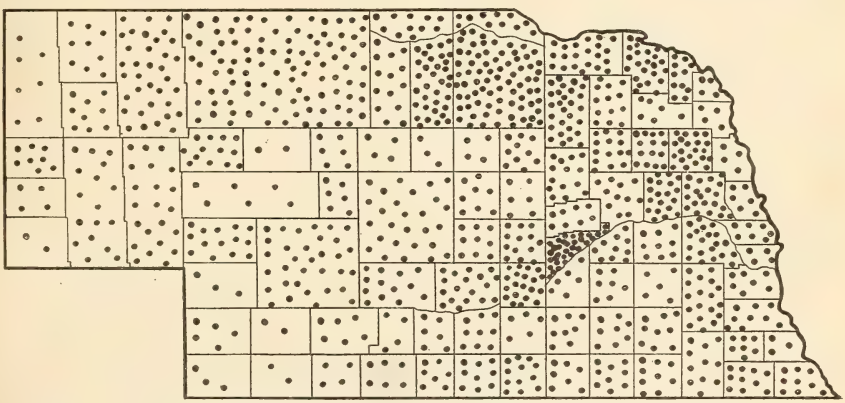

FIG. 1.—Localities in Nebraska where prairie hay is grown. Each dot represents 2,000 acres.

tics given in the Report of the Twelfth Census, where it is shown that in 1899, out of a total valuation for all crops of $2,910,138,663, the value of the hay and forage crop was $484,256,846, or 16.6 per cent.

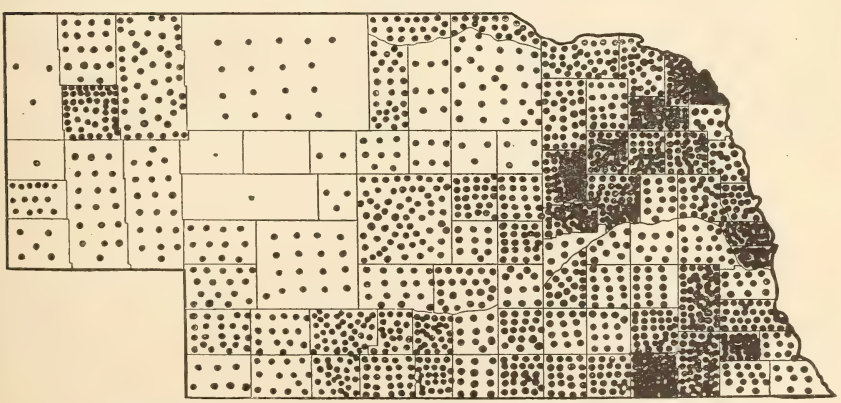

FIG. 2.—Localities in Nebraska where millet is grown. Each dot represents 100 acres.

The value of this crop is greater than that of any other, with the single exception of corn, which had a valuation that year of $828,258,326.

From the same source it is learned that out of a total valuation of $92,056,580 for all crops grown in Nebraska in 1899, the forage crop was worth $11,230,901, or 12.2 per cent.

TABLE I.—*Statistics for Nebraska of hay and forage crops for 1899, taken from the Report of the Twelfth Census.*

Total acreage devoted to hay and forage crops	2,823,652
Total acreage devoted to all crops	15,153,956
Total acreage of improved land	18,432,595
Per cent of acreage of forage crops to that of all crops	18.6
Per cent of acreage of forage crops to that of improved land	15.3
Value of all crops	$92,056,580
Value of forage crops	$11,230,901
Per cent of value of forage crops to that of all crops	12.2
Average value per acre of all crops	$6.07
Average value per acre of forage crops	$3.98
Tons of forage crops (excluding cornstalks)	3,502,380
Average value per ton	$3.19

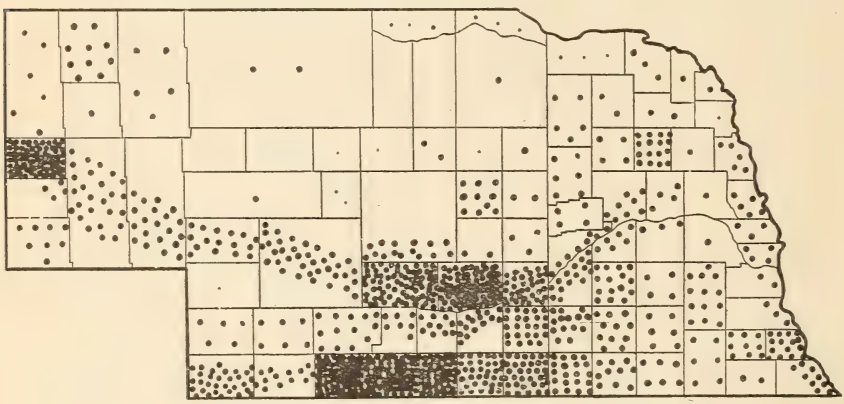

FIG. 3.—Localities in Nebraska where alfalfa is grown. Each dot represents 100 acres.

During the year mentioned Nebraska produced 2.3 per cent of the total valuation of the forage crop of the United States, ranking thirteenth in this respect. New York was first, with 11.4 per cent. The records show that during the last three decades the average yield per acre in Nebraska has decreased, while that of the entire United States has increased:

Year.	Nebraska.	United States.
	Tons.	*Tons.*
1899	1.2	1.4
1889	1.3	1.3
1879	1.5	1.1

In 1880 Nebraska was eighteenth among the States in the per cent of the total acreage that was devoted to forage crops, the percentage being 1.7. In 1890 and 1900 it stood ninth, with a percentage of 4.6.

In tonnage the figures are much the same, Nebraska ranking in 1860 as the thirty-second State in the Union, with only 0.1 per cent of the total; in 1870, twenty-third, with 0.6 per cent; 1880, fifteenth, with 2.2 per cent; 1890, ninth, with 4.7 per cent; 1900, ninth, with 4.4 per cent.

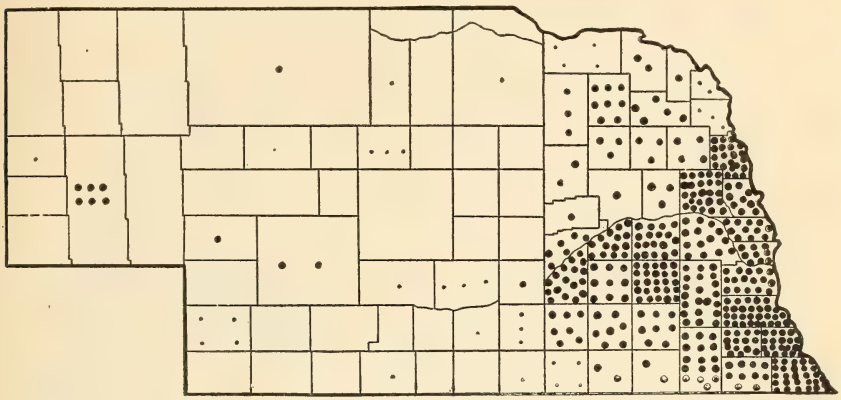

FIG. 4.—Localities in Nebraska where clover is grown. Each dot represents 100 acres.

Equally interesting are the figures showing the acreage, tonnage, and yield of the various forage crops in 1899, as classified in the census report, as follows:

Crop.	Rank of State.	Acreage.	Tonnage.	Average yield per acre.
				Tons.
Prairie hay	1	2,248,927	2,416,468	1.1
Millet	2	191,347	357,356	1.9
Alfalfa	6	115,142	275,334	2.4
Clover	15	42,447	72,747	1.7
Other tame grasses	27	92,895	143,109	1.5
Coarse forage	9	90,828	183,097	2.0

For comparison the following table is given of the acreage of the leading States for the above crops:

Crop.	State.	Acreage.
Millet	Kansas	349,906
Alfalfa	Colorado	455,237
Clover	Indiana	776,810
Other tame grasses	New York	4,758,523
Coarse forage	Kansas	1,041,447

In this classification the term "other tame grasses" includes in Nebraska chiefly timothy (also timothy and clover mixed) and bromegrass, and some bluegrass. Forage refers to sorghum, Kafir corn,

and corn that was cut green for forage. It does not, however, include corn that was cut and allowed to ripen in the shock, or what is usually known as corn fodder.

It appears that Nebraska also produced 8,156 bushels of clover seed, valued at $37,332, and 41,816 bushels of other grass seed, valued at $32,450.

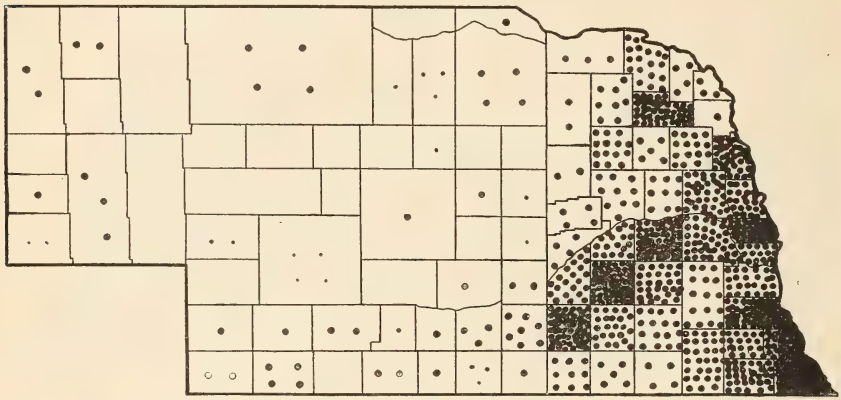

FIG. 5.—Localities in Nebraska where tame grasses are grown. Each dot represents 100 acres.

The accompanying maps (figs. 1–6) show graphically the distribution of the chief forage crops of Nebraska by counties. The distribution is based upon the tables given above. Each large dot represents 100 acres, except in the map illustrating the acreage of prairie hay, where each

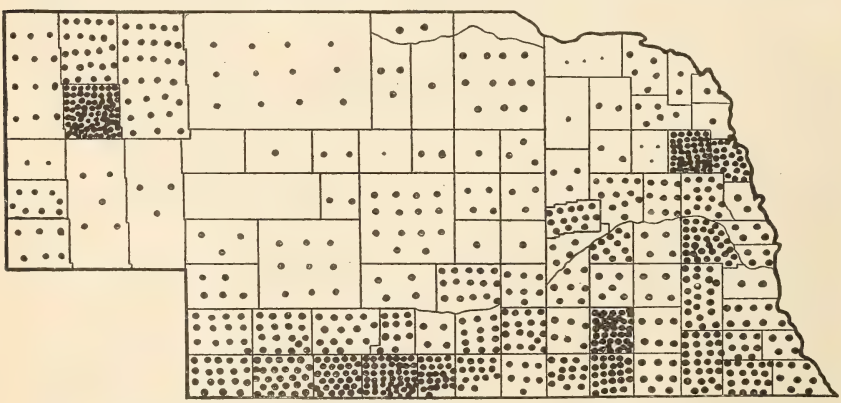

FIG. 6.—Localities in Nebraska where coarse forage is grown. Each dot represents 100 acres.

dot represents 2,000 acres. From 50 to 149 acres would be represented by one dot; 150 to 249 acres by two dots. Each small dot represents 10 acres and is used for acreages from 5 to 49. On the alfalfa map the dots in certain western counties are congregated in the vicinity of the Platte and Republican rivers, although the figures given in the tables do not indicate the distribution within the counties.

CLIMATIC AND SOIL CONDITIONS OF NEBRASKA.

RAINFALL.

For details concerning the rainfall the reader is referred to Bulletin No. 45 of the Nebraska Station, "The Rainfall of Nebraska," by G. D. Swezey and George A. Loveland. Since the amount and distribution of the rainfall is one of the most important factors in determining the agricultural possibilities of a country, it is well to summarize here the chief points as indicated in that bulletin.

The annual rainfall decreases from 34 inches in the extreme southeast to 13 inches in the extreme southwest. However, the average rainfall does not tell the whole story. Much depends upon the distribution of rain through the year, and especially during the growing

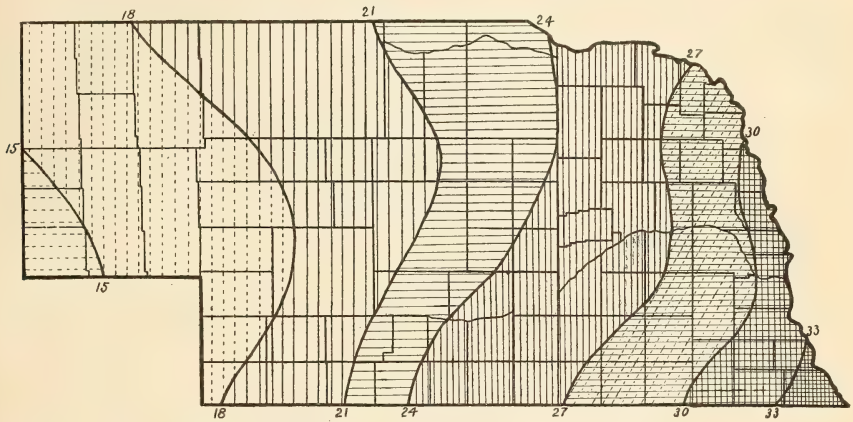

FIG. 7.—Normal annual rainfall for Nebraska, in inches.

season. The average rainfall for the entire State is 23.33 inches, of which 16.08 inches, or 69 per cent, falls in the five months from April to August, inclusive.

TABLE II.—*Average monthly precipitation for Nebraska.*

Month.	Precipitation.	Month.	Precipitation.	Month.	Precipitation.
	Inches.		*Inches.*		*Inches.*
January	0.68	May	3.62	September	1.84
February	.71	June	3.93	October	1.49
March	1.16	July	3.51	November	.68
April	2.40	August	2.62	December	.69

An examination of the table and of the accompanying charts (figs. 7 and 8) shows that it is only in the eastern tier of counties, lying approximately within the region receiving as much as 30 inches average rainfall, that the common eastern meadow and pasture grasses, such as timothy, red clover, redtop, and Kentucky bluegrass, will thrive with

a fair degree of certainty. The next region, included between 27 and 30 inches, is one in which these grasses may do well in favorable localities, but are more or less uncertain, and are quite sure to fail in dry seasons. On account of the lower summer temperature, these grasses may extend farther west in the northern part of the State than in the southern portion. For this belt, orchard grass and meadow fescue are more likely to be successful than timothy and clover, while brome-grass

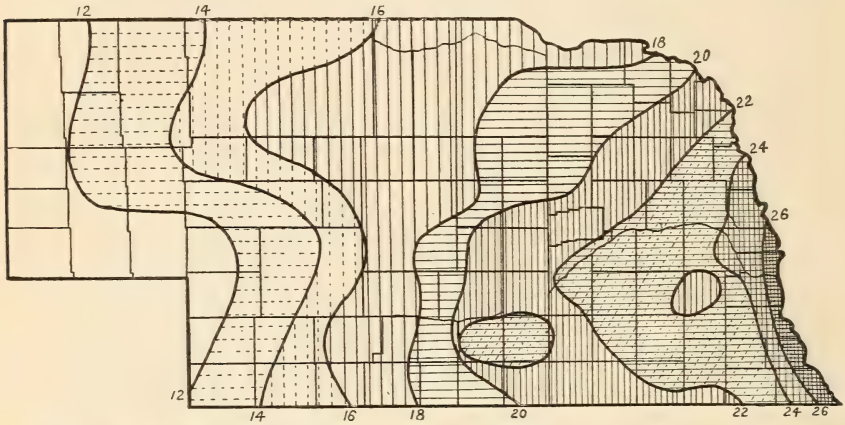

FIG. 8.—Normal rainfall in Nebraska during the growing season, April to September, in inches.

is the only satisfactory cultivated pasture grass west of this. Even brome-grass fails in the extreme west.

TEMPERATURE.

Prof. George A. Loveland, director of the Nebraska section of the Weather Bureau, has furnished the normal monthly temperature for several stations distributed over the State, which data are incorporated in the following charts. Besides these are given the normal annual temperature for the same stations, the average yearly minimum and the lowest recorded temperature for each station.

TABLE III.—*Normal monthly temperature, normal annual temperature, average minimum and absolute minimum for several stations in Nebraska.*

Town.	County.	Normal monthly temperature.												Annual temperature.	Average minimum temperature.	Absolute minimum temperature.
		January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.			
Lincoln	Lancaster	21.3	23.5	36.6	51.7	61.8	70.9	76.3	74.7	66.4	55.0	38.7	29.4	50.6	−15.4	−29
Auburn	Nemaha	25.7	25.0	38.0	54.1	63.1	71.9	77.0	75.5	67 2	56.5	39.8	29.6	52.0	−18.2	−35
Crete	Saline	21.1	23.5	35.6	52.3	61.1	70.4	75.7	73.3	65.8	54.0	37.6	27.6	49.8	−15.8	−32
Hebron	Thayer	23.8	25.7	37.2	53.9	62.4	71.7	76.6	74.5	66.5	54.4	38.4	30.0	50.5	−16.7	−34
Harvard	Clay	24.4	22.4	34.7	51.1	60.9	70.4	75.5	73.8	64.9	52.5	35.6	27.0	49.5	−18.2	−33
Beaver City	Furnas	28.9	26.6	38.8	51.6	62.8	71.0	76.2	75.3	66.9	54.6	39.6	31.1	52.1	−19.0	−35
Imperial	Chase	27.2	26.3	36.2	49.8	60.0	70.2	75.8	74.6	65.1	51.7	37.0	28.6	50.3	−21.2	−35
North Platte	Lincoln	20.0	25.3	35.1	48.6	58.2	67.9	73.5	71.4	62.4	49.8	35.2	27.1	47.9	−19.5	−35
Ravenna	Buffalo	24.4	22.9	34.7	50.9	59.6	69.0	74.4	73.0	64.7	52.3	36.0	28.5	49.2	−19.4	−38
Genoa	Nance	19.1	22.0	33.2	49.8	60.3	69.9	75.2	73.2	64.0	50.7	34.4	24.4	48.0	−20.2	−35
David City	Butler	21.4	20.8	31.8	50.0	58.9	69.1	73.7	70.9	63.0	50.6	33.9	26.1	47.5	.....	−30
Fremont	Dodge	18.5	21.0	34.0	50.6	60.2	70.5	75.3	72.6	64.5	52.6	35.6	25.0	48.4	−20.9	−31
Omaha	Douglas	19.2	25.0	35.5	51.0	61.7	71.8	76.2	73.7	64.8	52.9	36.6	26.7	49.6	−15.2	−26
Stanton	Stanton	20.8	19.5	32.6	49.7	60.6	69.0	73.4	71.6	63.5	51.7	33.9	23.6	41.5	−20.5	−33
Oakdale	Antelope	18.9	19.2	31.1	49.6	59.0	68.8	73.8	71.6	62.5	49.8	32.7	25.3	46.9	−22.9	−40
Sioux City (Iowa)	.....	16.3	19.0	31.6	50.6	58.4	70.3	74.3	71.6	65.2	51.0	34.3	27.8	47.6	.....	.....
Santee	Knox	18.3	18.4	32.3	49.0	62.0	71.6	76.4	74.3	64.6	52.1	34.1	21.9	47.9	−21.3	−33
O'Neill	Holt	20.7	19.8	31.1	48.3	58.9	67.8	73.3	71.2	63.4	50.9	33.5	24.9	47.0	−24.0	−33
Valentine	Cherry	16.9	21.5	31.2	47.2	55.8	67.2	73.3	70.3	61.6	49.2	34.3	27.2	46.3	−23.1	−37
Kimball	Kimball	26.9	23.9	33.1	46.3	55.8	65.8	71.6	70.6	61.0	48.6	36.2	28.5	47.5	−20.3	−30
Fort Robinson	Dawes	23.3	22.5	33.2	47.0	56.4	65.9	72.0	70.8	61.2	49.0	35.2	28.2	47.1	−23.8	−37

PHYSIOGRAPHY.

Nebraska lies in the central portion of the Great Plains region, and extends from the Missouri River to the foothills of the Rocky Mountains, 104° west longitude, and between the fortieth and forty-third parallels of latitude. The area is 76,794 square miles.

As to general topography, the State is little diversified, consisting for the most part of undulating prairies. The extreme eastern portion of the State along the Missouri River is forested, or was covered with forest before the timber was removed. These forests extended west along the rivers, the trees becoming fewer in number and species until they finally disappeared about halfway across the State. The prairies are covered with herbaceous vegetation, a large proportion of which consists of various species of nutritious grasses, which will be discussed briefly in another paragraph.

The altitude varies from a little less than 1,000 feet in the southeastern part to about 5,000 feet in the western portion of the State.

For a discussion of the botanical areas of the State and their relation to climatic and soil condition, the reader is referred to various articles by Dr. C. E. Bessey, in the reports of the Nebraska State Board of Agriculture, and more particularly to the Phytogeography of Nebraska by Pound and Clements.

SOIL.

A full discussion of the soils of Nebraska is given in the report of the geologist, E. H. Barbour, in the Annual Report of the State Board of Agriculture for 1894, page 61. It may be remarked that the basis of the agricultural soils of Nebraska is silt rather than clay, such as is found in the Eastern States. The State is divided into five soil regions, two of which—the Bad Lands and the Western Region—are in the extreme western portion of the State, and do not lie in what is now a crop district. The other three are the Drift, Loess, and Sand Hill regions. From the crop standpoint the first is the most important, as it lies in the region of greatest rainfall. The Drift is of glacial origin, and is agriculturally a rich soil. The Loess, or wind drift, is a deposit covering all the southern portion of the State, and is also a rich soil. The Sand Hills, which comprise the northern portion of the State north of the Platte and extend from Holt to Deuel counties, are less adapted to crops, but locally, where the conditions of moisture are favorable, results show that the agricultural possibilities are considerable.

In general, it may be said that the soils of Nebraska are highly favorable for the production of crops and the product is limited chiefly by rainfall and to a less extent by temperature. In many parts of the State there are small areas of soil, known as gumbo, which are poorly suited to crops, being too alkaline or too poorly drained. But such areas are relatively very insignificant.

CROPS.

East of the one hundredth meridian the rainfall is usually sufficient for the cultivation of crops without irrigation. This meridian is approximately that precipitation line for the annual rainfall of 20 inches. West of this, crops of some kinds are uncertain under the present methods of farming, although winter wheat and such drought-resistant plants as sorghum and Kafir corn are grown. The climate here is characterized by being very hot in summer and very cold in winter. The snowfall is usually slight. It is in this region that irrigation has reached its greatest development, although it is practiced occasionally in the eastern portion of the State to supplement the rainfall.

The following tables, taken from the Twelfth Census report, give the available statistics for irrigation in Nebraska:

TABLE IV.—*Number of acres irrigated, by counties, 1899.*

County.	Acres.	County.	Acres.	County.	Acres.
Buffalo	1,393	Holt	2,218	Scotts Bluff	29,244
Cheyenne	21,288	Keith	12,646	Sioux	1,433
Dawes	4,027	Kimball	4,225	All other counties	10,083
Dawson	20,097	Lincoln	22,508	Total	148,538
Deuel	11,794	Platte	1,488		
Dundy	4,552	Redwillow	1,542		

TABLE V.—*Acreage of crops produced on irrigated land, 1899.*

Crop.	Acres.	Crop.	Acres.	Crop.	Acres.
Corn	33,078	Alfalfa or lucern	22,172	Sweet potatoes	5
Wheat	14,143	Clover	47	Onions	68
Oats	5,090	Other tame and cultivated grasses	206	Miscellaneous vegetables	651
Barley	940	Grains cut green for hay	892	Dry peas	2
Rye	741	Forage crops	417	Grapes	7
Buckwheat	10	Dry beans	126	Orchard fruits	1,234
Prairie grasses	47,890	Potatoes	1,075	Small fruits	64
Millet and Hungarian grasses	868				

Most of the irrigation is along the Platte River, from Dawson County to the western border of the State, and is maintained by ditches from the rivers. A few acres are irrigated by windmills and wells (843 acres in 1899).

It follows that in the western portion of the State, aside from the comparatively insignificant irrigated areas, the principal industry is stock raising. The herds are allowed to graze all summer and a considerable portion of the winter upon the open grassy plains or range. The wandering of the herds is usually limited principally by access to water.

Stock raising is also an important industry in the eastern portion of the State, but the amount of open range is becoming much reduced. On the other hand, on account of the greater rainfall and other conditions favorable for growing forage crops, the same area will support more stock than in the western portion.

The principal field crops grown in Nebraska, arranged according to their value, are corn, wheat, oats, hay and forage, potatoes, and vegetables.

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The following table gives the acreage and value of these crops for 1899:

TABLE VI.—*Acreage and value of crops for 1899.*

Crop.	Acreage.	Value.
Corn	7,335,187	$51,251,213
Wheat	2,538,949	11,877,347
Oats	1,924,827	11,333,393
Hay and forage	2,823,652	11,230,901
Potatoes	79,901	1,734,666
Vegetables	34,044	1,383,470

Of lesser importance are rye, barley, fruit, sugar beets, and broom corn.

CLASSIFICATION OF FORAGE PLANTS.

Forage plants may be classified, according to duration, into perennials and annuals; according to kind, into grasses, legumes, and miscellaneous; according to use, into pasture, meadow, soiling, and silage plants.

DURATION.

Perennials.—This group includes those plants which live more than one year. The forage plants under consideration are all herbs, of which most of the portion above ground dies during winter, but the roots live and throw up new shoots the following spring. For most purposes it is manifestly an advantage that a crop should yield returns year after year without the expense of reseeding. On the other hand, the actual yield of forage the first season is almost always less with a perennial than with an annual, and furthermore, a perennial may not lend itself to the most desirable rotation. The important perennial forage crops of Nebraska are alfalfa, clover, bromegrass, timothy, and bluegrass. Some of these, such as timothy and clover, are known as short-lived perennials; that is, as a crop they tend to disappear in two or three years to such an extent that they need reseeding. This is also true of such grasses as Italian rye-grass.

Annuals.—These are plants which reach their maturity during the season that they are planted and then die. Common examples of this group are the grains, corn, sorghum, millet, cowpea, soy bean, and rape. Where land is valuable and it is necessary to grow a maximum crop upon a given area, annuals are more profitable as forage crops than perennials; or when it is desired to produce a crop at a given season of the year, such as early or late pasture of rye, a succession of succulent forage for dairy cattle, or a catch crop to utilize the land, annuals are invariably used.

Some plants, which are normally annuals, are sown in the autumn, and after making a growth of foliage that season, lie more or less dormant during the winter and resume growth the following spring, reaching maturity in the early summer. This is true of rye, some varieties of wheat, and some of the grasses. The severity of the winter determines in many cases whether plants may be used in this way. Many crops that are spring sown in the Northern States are fall sown in the South. Furthermore, some plants can be made to live for an abnormally long period by frequent mowing, thus preventing the production of seed.

NATURAL GROUPS.

Legumes.—This important group of plants includes the clovers, alfalfa, the cowpea, soy bean, the vetches, the garden beans and peas, and all similar plants, and it derives its importance from the fact that both the seeds and the foliage are richer in nitrogen than other forage plants. Since the proteids, or nitrogen-containing materials, are the most expensive portion of feeding rations, the growing of legumes for forage has long been recognized as an important factor in the economy of agriculture. But furthermore, as is well known, the legumes have the power, not possessed by other forage plants, of utilizing the free nitrogen of the air by means of the nodules on their roots. (See Pl. II.) When legumes are turned under as green manure, or even if the tops are removed by mowing and the roots allowed to remain in the soil, the nitrogen content of the latter is increased. Since nitrogen is a very essential plant food, and is one of the first to be exhausted in soils upon which crops are grown, and since this element is the most expensive to add in the form of fertilizer, the importance of growing legumes in rotation with other crops for the purpose of renovating the soil is quite evident. These facts emphasize the necessity of adopting a system of agriculture for a given region which shall include the growing of suitable crops of legumes in the rotation, thus utilizing the crop as forage and at the same time keeping up the fertility of the soil. The leguminous forage crops adapted to Nebraska are alfalfa and red clover, which are perennials, the latter usually short lived, and cowpeas and soy beans, which are annuals. In addition to these, white clover and alsike clover are occasionally used.

Grasses.—The great bulk of the forage plants, not included in the above group of legumes, belongs to the natural group of plants known as grasses, which includes besides the common meadow and pasture grasses, both wild and cultivated, such plants as the grains or cereals, sorghum, millet, and the sugar cane of the South. The grasses do not have the power of adding nitrogen to the soil after the manner of the legumes. Most of our native grasses are perennials, as are also our

cultivated pasture and meadow grasses, such as brome-grass, orchard grass, meadow fescue, and timothy, though the latter is short lived.

Miscellaneous.—Aside from the two large groups mentioned above there are a few forage plants which bear no close natural relation to these and are most conveniently considered under this heading. The only important plant of this category that is adapted to Nebraska conditions is rape. Australian saltbush belongs here and has received some attention, but as yet it has not shown itself to be of particular value in that State.

METHODS OF UTILIZING THE CROPS.

Pastures.—In general the term pasture may be applied to all cases where stock is allowed to feed directly upon the growing plants. Where the area is unfenced and consists of native vegetation it is called open range, or simply range. In some parts of the United States, especially the Southern States, the range consists of forest, but in Nebraska the range is the unfenced portion of the Great Plains region, the vegetation consisting of native grasses. The subject of the range will be considered in another part of this bulletin.

In the ordinary and popular sense pasture refers to fenced areas of native or cultivated perennial forage crops upon which stock feeds at will. All the perennial forage plants are used for this purpose, although alfalfa and clover must be used with caution in order to prevent bloating.

Another important class of pastures, especially where land is relatively valuable and a more intensive system of agriculture is employed, is that of temporary or annual pastures.

In winter-wheat regions it is a common practice to pasture the grain during favorable portions of the fall and winter. In this case the pasturing is incidental. On the other hand it is a not uncommon practice to sow wheat or, more frequently, rye in the fall for pasture purposes alone, a crop of grain, if secured at all, being secondary. Temporary pastures are used for two purposes. (1) To extend the pasture season over a greater portion of the year than can be done with ordinary permanent pasture. For this purpose wheat or rye give early and late pasture, and certain summer annuals can be used to supplement the permanent pastures during the dry summer season, which usually occurs in July or August. (2) By successive sowing of the proper plants succulent feed may be provided through the season so as to yield a maximum crop from each area. This is particularly applicable to dairy districts. It is often convenient and economical in growing a succession of succulent crops to cut the green feed and supply the stock either in the permanent pasture or in the stalls or yards, as will be referred to under soiling. The proper rotation of such annual pasture for Nebraska will be discussed in a separate paragraph.

The plants which can be used to advantage in Nebraska for temporary pasture are the grains as mentioned above, rape, cowpea, and soy bean. The various kinds of sorghum, especially the ordinary sugar sorghum or cane, are used in Texas and northward for this purpose. In the southern portion of this area sorghum can usually be used for pasture with impunity, but in Nebraska its use in this way is attended with some risk from poisoning. An account of this subject will be found in Bulletin No. 77, Nebraska Experiment Station.

Meadows.—The term meadow is applied to land where the crop is cut for hay, whether fenced or unfenced. When the hay is cut from native grass land, the land is called a wild meadow. As shown by the statistics in the first part of this bulletin, the wild meadow land of Nebraska amounts to over 2,000,000 acres and produces about 2,500,000 tons of hay. Nebraska leads all States in the acreage of its wild meadows. The grasses composing this wild hay will be discussed in another paragraph devoted to the native grasses.

The tame meadows consist in that State of alfalfa, timothy, clover, and brome-grass. Orchard grass and meadow fescue are used to a limited extent and their wider use is to be recommended.

Some annual plants are widely used for hay, such as millet, sorghum, Kafir corn, and corn. For this purpose the last three are sown thickly in order to produce a large number of small stalks.

These coarse plants are often grown in rows and cultivated, the nearly mature stalks being cut by hand or with a corn binder and shocked, when the dried material is called fodder rather than hay. In a general sense, however, it is hay and contributes no inconsiderable amount to the sum total of dry, rough feed. The same remarks are true of the corn fodder which results after the ears have been removed, although such fodder if it is gathered at the time most favorable for grain production from necessity is relatively poorer in nutrient material than that cut earlier. Ordinary corn fodder has about the same feeding value as oat straw. When corn is husked in the field the remaining stalks are usually utilized by turning stock upon them. Aside from the waste grain recovered such stalks have very little nutriment.

In the Southern States the cowpeas and soy beans are widely used for hay, but in Nebraska they have not been used for this purpose, for which they are not so well adapted as other hay plants.

Soiling crops.—The feeding of cut green forage to stock in the stall, yard, or pasture is known as soiling. The advantage of soiling is the saving of fodder when compared with pasturing upon the same field, as in the latter case there is some loss from trampling. This is especially true of the coarse fodders, such as corn and sorghum. Other advantages of minor importance are that by soiling the rations of animals may be more definitely controlled, that fodder may be taken from fields a part of which is to be used for other purposes, and that this

method avoids the necessity in pasturing the fields of subdividing them by erecting permanent or temporary fences. The great disadvantage of soiling is the extra expense of the labor necessary in cutting, hauling, and feeding the green forage. For this reason it is not practicable to utilize forage in this way on any large scale except in intensive farming, more particularly dairy farming in Nebraska. On a small scale almost every farmer cuts in early summer green grain, especially oats or rye, to feed to hogs or cattle. Later in the summer corn is cut and fed in the same manner, supplementing the pastures, which usually develop a shortage in August. The sum total of forage used in this way in Nebraska is not inconsiderable, yet in most cases it is incidental and the crops are not sown primarily for soiling purposes; neither is the soiling usually a definite part of the system of agriculture.

In dairy farming it may be advantageous to adopt soiling as a definite system in order to obtain a maximum yield of succulent forage from a small area. For this purpose it is best to plan a series of crops which will form a succession through the growing season. The individual crops depend upon the locality and must be chosen to suit conditions. Near large cities, where land is valuable, it often pays to have such a succession which, combined with silage during the winter, will give green feed the entire year. Usually, however, at least in Nebraska, soiling is resorted to only to fill in the gaps of a succulent pasture series, even in dairy farming. For example, early and late green feed may be produced by a pasture of rye. A proper sowing of oats or rye may then furnish soiling in connection with grass pasture. If there is sufficient area of pasture this may furnish all the feed necessary during May and June, but such pasture usually shows a marked falling off about the 1st of July, as is indicated by the shrinkage in the milk flow. This shrinkage should by all means be avoided, and it is therefore desirable to furnish at this time soiling crops for the rest of the summer in connection with the pasture. Besides the small grains and corn mentioned, there are several other plants that can be used for soiling, particularly sorghum, Kafir corn, cowpeas, soy beans, and rape. The latter is not so well adapted to milch cows, as there is danger of tainting the milk. Alfalfa and clover can be used, but in Nebraska they have no special adaptation for this purpose. Rape is an excellent soiling crop for hogs, sheep, or growing cattle during the autumn. For further information on this subject the reader is referred to the article in the Yearbook of the United States Department of Agriculture for 1899, page 613, entitled "Succulent forage for the farm and dairy," by Thomas A. Williams.

Silage.—Forage preserved in a green state in such a manner as to prevent decomposition or drying is called silage. The pits, rooms, or tanks in which the forage is preserved are known as silos. The

advantage of silage is that the benefits derived from feeding succulent forage may be continued through the winter. As in the case of soiling crops, silage is used chiefly in connection with dairy farming. By far the best crop for the silo, where that crop can be raised, is green corn. As it is not the purpose of this bulletin to deal particularly with this subject, the reader is referred for further information to Farmers' Bulletin No. 32 of the United States Department of Agriculture and to other publications dealing with silos and silage.

RESULTS OF EXPERIMENTS WITH GRASSES AND FORAGE PLANTS AT THE NEBRASKA EXPERIMENT STATION.

GRASSES AND FORAGE PLANTS WHICH HAVE GIVEN SUCCESSFUL RESULTS OR ARE WORTHY OF FURTHER TRIAL.

Brome-Grass.

An extended account of brome-grass (*Bromus inermis*) will be found in Bulletin 61 of the Nebraska Station and also in Circular 18 of the Division of Agrostology, United States Department of Agriculture. This valuable grass has been tested over a wide area in the United States, but it finds its best development in the region from Kansas northward in the Great Plains, and west into Montana and eastern Washington. It gives fair results east of this region, but in the Eastern States is unable to compete with timothy and bluegrass. In the Southern States it has not given satisfactory results.

Numerous trials of this grass have been made at the Nebraska Station under varying conditions, both in combination with other grasses and with alfalfa. In general the grass has given good results and has shown that it is better adapted to the conditions obtaining in Nebraska than any other of the cultivated forage grasses, with the exception of meadow fescue and possibly orchard grass, both of which have given good results.

A plot sown in the spring of 1897 (0.136 acre) yielded June 27, 1900, 580 pounds of hay, or at the rate of 2.32 tons per acre. On April 8, 1901, as the grass was turning green, the east half of the plot was disked. During the remainder of the season there seemed to be no difference between the disked and undisked portions. In 1903, the plot yielded 1.32 tons of hay per acre on June 16. Other plots yielded at about the same rate.

One plot sown in April, 1899, and giving a cutting of hay June 27, 1900, at the rate of 3.8 tons per acre (220 pounds on 16½ by 76 feet) was treated October 5 with 300 pounds of well-rotted horse manure, and the following spring with 10 pounds of sodium nitrate (Chile saltpeter). On account of the drought no crop of hay was obtained in 1901, but this plot was distinctly better in appearance than untreated contiguous plots. June 16, 1903, the plot yielded 170 pounds of hay,

or 5,666 pounds per acre, while a check plot yielded at the rate of 2,166 pounds per acre.

One plot sown in spring of 1900 and manured in the autumn of 1901, gave June 23, 1902, 1.66 tons of hay per acre, and June 16, 1903, 1.7 tons, and in each case the aftermath was fine and would have produced an excellent pasture.

The plots were all greatly affected by the drought in the summer of 1901, but recovered in the autumn and showed that although they had been dried up they were unhurt.

A sowing at the rate of 14 pounds per acre on one plot showed that much more seed was produced than upon plots more thickly sown. This plot was thoroughly disked in the spring of 1903, with the result that the growth the following season was not improved.

In order to test spring and fall sowing, one plot was sown October 5, 1900, at the rate of 25 pounds per acre, upon disked land, and another April 8, 1901, at the same rate and upon ground prepared in the same way. Although there was a good stand of grass obtained from fall sowing, there was no noticeable difference the following season between the two plots.

In order to test the time of seeding several plots were sown broadcast on the following dates in 1902: March 24, April 8, April 21, May 7, May 19, August 7, August 19, September 15, October 1, and October 21. All showed a good stand on May 1 of the following year and no injury from winter killing, except the last sowing, which had barely sprouted and was then killed by the cold. With this exception all yielded good crops of hay on June 23. (See Pl. III, fig. 1.)

If the soil is in proper condition it is probable that brome-grass may be sown any time from April to the first of October.

Brome-grass was sown in 1898 with bluegrass and with red clover. In both cases there was a good stand of brome-grass at first, but where combined with bluegrass the latter gradually increased in proportion until in 1903 it was estimated that the plot contained two-thirds bluegrass.

The red clover was also able to hold its own with the brome-grass in those years favorable to the growth of clover, but the dry season of 1901 nearly exterminated the clover from the plot.

In the paragraph upon pastures it will be noted that when brome-grass was sown with other grasses it was usually able to crowd out its competitors.

RESULTS OF COOPERATIVE EXPERIMENTS.

The United States Department of Agriculture has distributed seed of brome-grass through the Nebraska Experiment Station to a number of farmers with the understanding that reports upon the results obtained would be made. These cooperative distributions were made between 1898 and 1902.

There were 170 replies received from those who have grown brome-grass, of which 36 reported failures. Of these failures 26 were in the southwestern portion of the State, from McPherson to Chase and Franklin counties. The reasons for failure were mostly because the seed did not germinate or gave a very scattering stand, but 8 failures were due to the depredations of grasshoppers.

The remaining 134 replies have been summarized as follows: The present condition of the field of grass was reported good by 100, while 13 stated that the condition was poor. Spring sowing was recommended by 86 and fall sowing by 22. That a stand of brome-grass is easier to obtain than of other grasses was stated by 48, while 42 thought that this was not the case. A few had tried sowing brome-grass with other crops but with varied results. With alfalfa, there were 5 successes and 2 failures; with clover 3 successes and 2 failures. Three reported a successful stand when sown upon prairie sod, while 5 failed in this. That this is a good hay grass was reported by 42, while 17 thought not. As a pasture grass, all except 2 reported favorably so far as this point was touched upon, while 42 stated that it was good for early and 49 for late pasture. Twenty-four stated that it was good for winter pasture. The drought resistance was reported good by 53 and poor by only one. The reports of 14 farmers showed that it was good for sandy soil and 50 stated that it made a good sod.

Alfalfa.

The well-known perennial legume alfalfa (*Medicago sativa*, Pl. II) is the most valuable forage plant grown in Nebraska. Every effort should be made to extend the culture of this plant to all parts of the State. Being a legume it is highly nutritious; being a perennial it produces a permanent meadow; being palatable it is relished by all kinds of stock. Although it is valuable as a pasture plant it is not entirely suited to this purpose. Close pasturing is likely to kill it out in spots. The great value of alfalfa lies in the production of hay. The reader is referred to Farmers' Bulletin No. 31, United States Department of Agriculture, for details in regard to this plant.

It may be briefly remarked here, however, that in growing alfalfa the ground should be well prepared, as free as possible from weeds, and the seed should be sown when the soil is in favorable condition for germination. The seed should be sown alone at the rate of about 20 pounds per acre, broadcast or, better, in drills. Where possible Nebraska-grown seed should be used, or at least seed grown under about the same conditions.

COOPERATIVE EXPERIMENTS WITH ALFALFA.

Press Bulletin No. 16 of the Nebraska Experiment Station, entitled "Alfalfa Experiences," gives the following summary of results obtained by growers of alfalfa in that State:

During the winter of 1902 a list of between 600 and 700 successful alfalfa raisers in this State was collected, and to each was sent a report blank calling for a definite statement regarding a number of the processes he employed in obtaining his stand of alfalfa, and also regarding his subsequent care of the crop. More than 500 satisfactory replies were received, representing 80 counties in the State. A study of this large number of reports from successful alfalfa raisers gives some valuable information respecting alfalfa culture.

There were 288 stands reported upon upland, and 273 upon bottom land. Even in the western portion of the State the amount of alfalfa on the upland is shown to be considerable, and very satisfactory results are evidently obtained, although naturally the yields of hay are smaller than on the bottom lands of that region. In the eastern part of the State somewhat heavier yields appear to be obtained from bottom land, but loss from winter killing or other cause is greater. Twenty-three reports state that upland is more satisfactory than bottom land. These come principally from the eastern portion of the State or the irrigated land of the western portion.

An astonishing feature of the replies is the large amount of alfalfa that they show to be growing on land with a clay subsoil. Sandy clay, clay loam, clay and lime, etc., were not counted as clay. In spite of this limitation, 245 clay or gumbo subsoils are reported. A clay or even a gumbo subsoil does not appear to be a barrier to successful alfalfa culture.

The seed bed was prepared by plowing and further working in 373 cases, and by disking or cultivating in 75. Among the latter is one method that appears to be popular and satisfactory. This consists in thoroughly disking corn land after all trash has been removed from the field. In the western part of the State there are a number of good stands of alfalfa obtained by breaking prairie sod, disking it, and harrowing in the seed. Also by disking the unbroken sod and harrowing in the seed. The latter commends itself as an easy way of supplementing the native grasses in pastures. The tendency to dispense with plowing on unirrigated land increases with the distance westward from the Missouri.

A study of the dates of sowing alfalfa seed in the spring shows a range from early March to late June, although where advice was volunteered it was practically unanimous in favor of early sowing. There were only 8 reports of summer or fall sowing, of which 1 was sown in July, 4 in August, and 3 in September.

In 108 cases a nurse crop was used, while in 393 cases the alfalfa seed was sown without that of any other crop. The use of the nurse crop was largely confined to extreme eastern Nebraska and the irrigated land of the West. Many persons who used a nurse crop say that they would not do so again. It has been recommended to use a light seeding of small grain, sown earlier or with the alfalfa, to prevent damage by severe winds. When sown in this way the nurse crop is mown when 8 or 10 inches high, to prevent it smothering the alfalfa.

In 55 cases the seed was put in with a drill, and in 447 cases it was sown broadcast. This is at least an indication that if a drill is not available a satisfactory stand can be obtained by broadcasting and harrowing in, provided the other conditions are favorable.

There were 138 reports of less than 20 pounds of seed per acre being used, and 336 reports of 20 pounds or more being sown. The evidence seems to be in favor of the use of at least 20 pounds of seed per acre.

Of the persons replying to the inquiries, 221 have stands of alfalfa that yield more than 4 tons of cured hay per acre each season, while 157 do not get as much as 4 tons of hay per acre.

Of persons having practiced disking alfalfa in the spring or at other times, 138 report that beneficial results have been obtained, while 7 report that disking has been ineffective or injurious. By disking alfalfa is meant going over it in the spring with a disk harrow before growth starts, or during summer immediately after cutting for hay. It is customary to set the disks at a slight angle. This cuts the crown root and stirs the soil. Some of the correspondents prefer harrowing to disking. Where positive objection was made to disking, it was based on the claim that it caused the crowns to become diseased. The great bulk of the evidence was, however, in favor of disking.

Of the persons who have manured alfalfa, either by plowing in the manure immediately before seeding or by spreading it on the field after a stand had been obtained, 110 obtained beneficial results, and 13 found it to be ineffective or injurious. Objections are based on the claim that plowing in manure causes the soil to dry out, but objections to spreading manure on alfalfa are rather indefinite in their nature, except that on low land it makes the growth too rank, and the alfalfa falls down. Many of those who advocate its use specify that the manure should be rotted and fine. One man suggests harrowing after spreading, to fine it. The reports of beneficial results from plowing under manure come largely from the eastern portion of the State, but the use of fine manure applied as a top dressing has proven beneficial in all parts.

ALFALFA SEED FROM DIFFERENT SOURCES.

Turkestan alfalfa.—One plot of one-fifth acre was sown alone with 5 pounds of seed April 8, 1901. There was a good stand and no loss from winter killing in 1901–2 or 1902–3, thus showing its superiority in respect to hardiness during the winter. On the other hand, this plot was injured by the wet weather in the summers of 1902 and 1903 to a greater extent than common alfalfa. On June 12, 1903, a crop of hay was obtained, weighing 605 pounds (3,025 pounds per acre), and a second crop on July 23, weighing 500 pounds (2,500 pounds per acre), making 2.75 tons of hay per acre, besides fall pasturage. It was noted that this plot started one week earlier in the spring than the ordinary alfalfa, but did not continue growth so late in the autumn. At no time did it grow so tall as ordinary alfalfa, but the stand was much thicker, and there appeared to be less tendency for the crowns to become large and crowd out weaker plants, as is the case with ordinary alfalfa. As compared with the latter the leaves and especially the stems are smaller.

A second plot, one-tenth acre,[a] drilled in rows 6 inches apart May 24, 1898, gave a good stand, with no loss from winter killing the first year and yielded 215 pounds of hay (2,150 pounds per acre) on June 17, 1899. The third year the yields of hay from one-eighth acre were

[a] The plots here, as in several other cases, are 66 feet by 76 feet and contiguous on the longer sides. If the marginal growth was greater than the central, 5 feet was mowed off each end, reducing the plots to 66 by 66 feet, or one-tenth of an acre, and thus eliminating the marginal factor.

as follows: June 14, 515 pounds; July 20, 590 pounds; August 20, 305 pounds, or a total for the season of 5.64 tons per acre.

In 1901 the yield on the one-eighth acre was: June 5, 645 pounds; July 19, 160 pounds; August 20, 125 pounds; a total of 3.22 tons per acre. In 1902 the yield on June 9 was 445 pounds; in 1903, June 11, 475 pounds; July 23, 365 pounds; a total of 3.34 tons per acre. The results of this test are especially satisfactory, as showing that Turkestan alfalfa is well adapted to Nebraska conditions, and that in a dry season such as 1901 it yields larger crops than the ordinary alfalfa.

Peruvian alfalfa.—Seed was obtained from C. Bonifiez, Peru, through the Division of Agrostology of the Department of Agriculture, and was sown on May 11, 1900. The stand was good and the growth vigorous, but the plot was badly injured each winter, till, in 1903, there was none remaining.

Samarkand alfalfa.—Sown May 11, 1900. The stand was good and subsequent growth vigorous, with no loss from winter killing; but the growth was not so tall as common alfalfa, or as Turkestan alfalfa. In 1902 and 1903 crops were obtained from this plot, but the plot is too small for an accurate estimate of the yield to be determined. Owing to the small growth, it was estimated that the yields were less than from the ordinary or the Turkestan alfalfa. To offset the effect of shorter growth the stand is much thicker than that of ordinary alfalfa. It appears to be a strong drought-resisting plant, and if it is to have any value it will be on the highlands of the West.

Seed from different States.—Alfalfa obtained from five different States—Arizona, California, Colorado, Kansas, and Utah—was tested. The plots were sown in 1898 by drilling the seed in rows 6 inches apart. They all grew about equally well until the winter of 1898–99, when the alfalfa from Arizona and California was almost entirely killed out. At the same time the Colorado alfalfa was injured, while the Utah and Kansas plants did not suffer so much as those just mentioned, though more than the Turkestan alfalfa or that from Nebraska-grown seed.

There was no further marked loss from winter killing until the winter of 1902–3, when the remainder of the Arizona and California plants entirely disappeared, the Colorado crop suffered further injury, and both the Utah and Kansas alfalfa were injured to some extent.

The conclusions to be drawn from this experiment are that it is not desirable to bring alfalfa seed from a southern to a more northern region, or from an irrigated to a nonirrigated soil.

OTHER EXPERIMENTS WITH ALFALFA.

A series of experiments was carried on for the purpose of testing the effect of planting alfalfa in rows and the effect of a few kinds of fertilizers. Plot 43, drilled 24 inches apart, and plot 44, drilled 18

inches apart, were cultivated by hand, and plot 45, drilled 6 inches apart, was cultivated by harrowing. The results show that there is little difference in the yield under the different treatments, and that there is no advantage in planting alfalfa in rows and cultivating it, at least under the conditions at the Nebraska Station. The individual plants tend to grow larger and the stems fall over, filling the space between the rows. As the larger crowns with age tend to rise above the soil, the mowing becomes more difficult and there is more loss of foliage than when the seed is sown thickly. It is quite possible that in the drier portion of the State the moisture could be conserved by cultivation and a crop produced when under ordinary methods there would be failure. On the other hand, the extra expense of such treatment is likely to more than offset any such advantage. In the Southern States alfalfa is frequently raised in rows and cultivated, as it can thus be more easily kept free from weeds; but such methods are used only on a small scale.

The treatment of plots with fertilizer showed no marked advantageous effect. Plots 46 to 49 were treated respectively with fertilizer at the following rate per acre: One ton gypsum, 1 ton lime cake, 2 tons lime cake, 3 tons hog manure.

In order to determine the effect of using heavy or light seed, common alfalfa seed was separated by a grain grader into approximately equal parts of heavy and light weight. This was sown by drilling in 1902. On June 23, 1903, a cutting was made from each plot. The light seed yielded at the rate of 2,500 pounds per acre, and the heavy seed at the rate of 3,000 pounds per acre. The notes made at the time show that both plots were weedy the first year, but the second year there was a much thinner stand in the plot from light seeds.

To test the effect of seeding at different times plots of common and Turkestan alfalfa were sown by drilling and by broadcasting from spring till fall, in 1902, on the following dates: March 10, March 24, April 8, April 21, May 7, May 19, August 7, August 19, September 15, October 1, October 21. On account of lack of seed the experiment with Turkestan alfalfa was discontinued after August 19. The plots of this variety showed a good stand in almost every case and no injury during the succeeding winter.

The sowings of common alfalfa during March, April, and on May 7 gave a fair to good stand, but were all seriously injured the following winter. Later sowings gave good results and not much injury from winter killing except that the sowing of October 21 was a failure, as the plants did not reach a sufficient size to withstand the winter. It was also observed that of the fall-sown plots those sown broadcast gave a much better stand than those that were drilled. (See Pl. III, fig. 2.)

These experiments, as well as the experience of alfalfa growers,

show that alfalfa may be sown at any time of the year from spring to early fall, provided the soil is in the proper condition as to tilth and moisture. In the eastern part of Nebraska summer and fall sowings may be advantageous because of the weeds. The soil may be freed from weeds during summer and thus the alfalfa is given a chance to get a start.

To test the relative value of sowing seed alone or with a nurse crop, two one-fifth acre plots were planted with 5 pounds of seed on April 8, 1901. On plot No. 1 the seed was sown alone. A good stand followed, with vigorous growth, though some plants were killed during the winter of 1902–3. The result was entirely satisfactory. The plot was disked in the same manner as No. 2. On plot No. 2 the seed was sown with 2 peck of oats. On June 28, 1901, 58 pounds of oats were gathered, followed by a fair stand of alfalfa by October. In the spring of 1902 the stand was very poor, but after being disked and harrowed (March 22) there was some recovery and a good stand resulted in the spring of 1903, though there had been some loss during the preceding winter. The results show that a good stand is more certain to follow sowing alone, the growth of alfalfa being vigorous the first season, while if sown with a nurse crop the alfalfa does not reach its maximum till the second season and there is some risk of a poor stand. The poor results the first season are partly offset by the oat crop gained.

A third plot was treated in the same manner as No. 2, with the intention of mowing the oats for hay, but the dry spring ripened the oats prematurely. The results otherwise were similar to plot No. 2.

A series of experiments has now been in progress for three years to test the effect of combining alfalfa with various grasses. In the spring of 1901 plots one-fifth acre in size were sown with the following mixtures:

Alfalfa, 5 pounds; brome-grass, 3 pounds.

Alfalfa, 4 pounds; brome-grass, 4 pounds.

Alfalfa, 4 pounds; bluegrass, 3 pounds.

Alfalfa, 4 pounds; meadow fescue, 5 pounds.

Alfalfa, 1 pound; brome-grass, ½ pound; red clover, ½ pound; white clover, ¼ pound; bluegrass, ½ pound; meadow fescue, ½ pound; orchard grass, ½ pound; timothy, 1 pound; perennial rye-grass, 1 pound; tall oat-grass, ½ pound.

Alfalfa, 4 pounds; timothy, 5 pounds.

In all cases there was a good stand of alfalfa the first year, and scarcely any of the grasses could be found. All of the plots were disked and harrowed in the spring of 1902. During this season there was a good growth of alfalfa and only a little grass to be seen. This result is especially noteworthy for the plot containing only 1 pound of alfalfa, with several grasses. It was not till the third year that the grasses began to assert themselves. In all the plots the grass constituted a considerable portion of the plots except in the case of the

mixture with timothy, which appears to be unable to compete with alfalfa. In the mixture of several grasses it was the orchard grass that took the lead, the plot being estimated to consist of about one-third of this grass.

Another plot of alfalfa and brome-grass sown in equal parts in 1899 has had a similar development, but at the present time the brome-grass has succeeded in nearly crowding out the alfalfa. In the plots where brome-grass was sown with alfalfa—both the common and Turkestan—it was noted that the grass appeared more vigorous in those places where the alfalfa was thickest, and that the grass in these plots appeared also to be more vigorous than in adjacent plots where there was no alfalfa. It would appear that the brome-grass derived some advantage from the fertilizing effect of the alfalfa. (See Pl. IV, fig. 2.)

It will be of interest to record here the results obtained by two correspondents in sowing alfalfa upon native grass in the sand-hill region.

William Fagan, foreman of the Robert Taylor ranch at Abbott, Hall County, states that he disked the sandy sod three times, lapping the disk half each time, and sowed 20 pounds of seed per acre. This was in the spring of 1902. A good stand was obtained, and in 1903 a crop of hay was cut consisting of about one-third prairie hay and two-thirds alfalfa. The alfalfa succeeded better on the knolls where the sod was more thoroughly broken.

Mr. H. W. Sullivan, Broken Bow, Custer County, states: "Beginning in the early spring and continuing up until August, I caused light sandy soil to be broken. I disked this well, harrowed it down smoothly, put seed in with a press drill, 15 pounds to the acre, and got a splendid stand on every foot of it." He remarks that the best stand seemed to follow the August sowing.

Meadow Fescue.

Meadow fescue (*Festuca pratensis*) is a native of Europe and has been cultivated in this country for many years. It can not compete with timothy where the latter is at its best, but being more drought resistant, its range is somewhat more extended in the West, as indicated in the paragraph upon orchard grass. It is more common in the Middle South, where it is grown as a winter grass, being sown in the autumn.

In Nebraska it is recommended that it be sown with orchard grass in the spring. It can also be sown alone or with clover, and in Nebraska is best adapted for pasture, though it can also be used for hay. For the latter purpose, however, brome-grass or alfalfa give better returns.

Many seedsmen sell meadow fescue under the name of English blue-grass, but the latter name is inappropriate, as the grass is not a

bluegrass, and the term English bluegrass is sometimes applied to a different plant.

A closely allied grass is tall fescue (*Festuca elatior*). Botanically they are usually considered to be the same species, but agriculturally there is considerable difference, and, for Nebraska conditions, in favor of the meadow fescue.

For further notes upon this grass see the paragraph upon grass mixtures.

One plot, 76 by 132 feet in size, sown in the spring of 1900 and manured in the fall of 1901, gave on June 23, 1902, 750 pounds of hay, or 3,450 pounds per acre. The grass was injured somewhat by the drought of 1901, but recovered sufficiently to give good fall pasture. The fourth year, June 16, 1903, this plot gave a cutting of hay of 670 pounds, or at the rate of 2,836 pounds per acre.

Another plot (one-eighth acre), drilled in rows on May 25, 1897, gave on June 27, 1900, a cutting of 300 pounds of hay, or at the rate of 2,400 pounds per acre. The growth in the following years was good, but the notes show that the grass does not start to grow so early in the spring as brome-grass.

Eight growers of meadow fescue have reported upon their results. All report that their fields are now in good condition, but the reports are equally divided as to the advantages of spring and fall sowing, while five state that it is easier to obtain a stand of this than of other grass. Several have tried meadow fescue mixed with timothy, clover, or alfalfa, all of which trials were successful.

Orchard Grass.

Orchard grass (*Dactylis glomerata*) is a native of Europe, but has been cultivated in this country since the middle of the eighteenth century. It is a bunch grass, and when sown alone forms tufts which in time become large tussocks, considerably raised above the general surface of the soil. This is a hindrance to the mowing machine and also a waste of land. For this reason it is recommended that orchard grass be combined with some other grass, for which purpose meadow fescue and brome-grass are best adapted to Nebraska conditions.

Orchard grass is one of the most nutritious and palatable of the cultivated meadow grasses. It thrives in more shaded situations than other meadow grasses, for which reason it is often planted in orchards; hence the name. It withstands drought better than timothy, and consequently can be grown farther west in Nebraska than can timothy. The chief disadvantage of orchard grass is the greater expense of the seed.

Orchard grass and meadow fescue, sometimes combined with red clover, are to be recommended especially for pasture in that part of Nebraska west of the timothy belt as far as about the ninety-ninth

meridian, beyond which the summer conditions become too severe. It is true that fields of these grasses usually dry up more or less during the middle of summer, but the same is true of all available pasture grasses, it being necessary to supplement them during this season with green feed, such as cane or corn. On the other hand, orchard grass and meadow fescue furnish green feed in early spring and late fall, seasons when the wild pastures are not available. The seed should be sown in the spring at the rate of about 20 pounds of orchard grass and 15 pounds of meadow fescue per acre. Unless the ground is free from weeds it will be necessary to mow once or twice during the first season to keep the weeds down until the grass is well established. When grown for hay the grass should be cut in blossom, as at a later period the value of the hay rapidly decreases.

Orchard grass has been grown on the Nebraska Station farm for several years and has given very satisfactory results. (See Pl. IV, fig. 1.) The reader is referred to the paragraph upon grass mixtures for further information as to this grass.

Timothy

Timothy (*Phleum pratense*) is a native of Europe, and is said to have been brought to Maryland in 1720 by Timothy Hanson, for whom it was named. The history of this standard meadow grass is somewhat obscure, however. The name herd's grass, by which it is known in New England, is said to have been derived from a Mr. Herd, who found it growing wild in New Hampshire and introduced it into cultivation. Timothy is cultivated in Europe, while in the United States it is the common meadow grass through all the Northern States as far west as eastern Nebraska and south to Virginia and Tennessee, and even farther in the mountains. It is also cultivated in the Rocky Mountains at high altitudes, in the irrigated districts of the Northwest, and the moist region of western Oregon and Washington.

Timothy is a less nutritious grass than most of the other cultivated grasses, but it has a great advantage from the fact that seed of good quality is easily produced for the market and hence is cheap, and because the grass may be easily grown and handled. In Nebraska timothy can be grown successfully only in the eastern counties, although it is being gradually pushed westward, and there are many fields that give fairly good results as far west as the ninety-ninth meridian, or even farther when there is an abundant water supply near the surface. However, these are isolated cases and represent localities where the conditions are especially favorable, and it can not be said that timothy is to be depended upon much west of the line indicating 30 inches of annual rainfall.

Timothy is chiefly used for meadows, but may be also used for pastures. When sown alone there is some danger of injury from close

pasturing, as stock are likely to pull up the bulblets at the base of the stems and thus destroy the crown. It is usually sown, when intended for pasture, with red clover. When used for hay it is also frequently combined with clover, which is very satisfactory for home use, as the clover increases its feeding value. Upon the hay market, however, pure timothy brings a higher price than mixed; hence when grown for sale timothy is usually sown alone.

It may also be remarked that the soil conditions of Nebraska are not suited to the best development of timothy, even where the rainfall is sufficient, as the soil is of a sandy type rather than clay. Timothy may be sown in the autumn or spring. If sown alone it is best to sow in the fall, as a full crop can then be obtained the following year. If sown in the spring there is not generally a full crop till the second year and hence some time is lost. It is usual in Nebraska to combine it with clover and sow with a nurse crop, the object of the latter being to obtain more from the land the first year. As the timothy and clover may not reach their full development the first season, the grain crop is thrown in for economy. Where winter wheat is grown it is common to use this as the nurse crop, sowing the timothy and wheat in the fall and the clover the following spring. The wheat and timothy can not be sown mixed in a drill on account of the difference in the size of the seed, but they may be sown at the same time by using a wheat drill having a special attachment. The timothy may be sown in the spring, but in that case should be sown early, about the time the snow is disappearing and while the ground is wet. If there is no snow and the ground is dry the timothy is likely to fail. The clover is sown in the spring in either case and later than is suitable for timothy, usually the first part of April.

The amount of seed used is from 6 to 8 quarts of timothy and 8 to 10 pounds of clover. When combined with grain the timothy and clover produce a good growth after the grass is cut, and may be lightly pastured the same year. The following year one or more crops of hay may be cut or the field may be pastured, according to circumstances. When timothy is sown alone there is some danger in Nebraska of injury to the roots after the cuttings, as they may be unduly exposed to the hot sunshine during dry weather. There is less danger of this when clover is used in combination.

Clovers.

Red clover (*Trifolium pratense*), the standard forage legume of the Northeastern States, can be grown in the eastern counties over about the same area as timothy. As clover is usually combined with timothy for both pasture and meadow, its cultivation has been considered in connection with the latter plant. In the census returns cited in the introduction to this bulletin mixed timothy and clover are included

under "other tame grasses." As Nebraska is credited with 42,000 acres of clover and 92,000 acres of other tame grasses, it is quite likely that a large proportion of the latter area is devoted to timothy and clover mixed. Red clover has been grown upon the Nebraska Station farm for many years with great success.

Mammoth clover is a variety of red clover of more vigorous growth and longer lived than the ordinary kind. The seed was sown at the Nebraska Station in 1900, and gave a good stand, a vigorous growth, with good fall pasture. The following year it was subjected to a severe test by drought, but withstood this better than any other clover upon the farm. It was about half winterkilled in the winter of 1902–1903.

Alsike clover (*Trifolium hybridum*) is a perennial clover, in size and appearance intermediate between red and white clover. It is adapted to more moist ground than red clover and is recommended as a constituent of wet pastures. In Nebraska it does not usually grow tall enough for hay, but is a fine clover for pasture. On the station farm alsike has given good results in low spots in pastures and has withstood drought well.

Kentucky Bluegrass.

Kentucky bluegrass (*Poa pratensis*) is a native of Europe and of the northern part of the United States, but it is now widely cultivated; it is also found as a wild grass throughout all the northern portion of the United States, except the arid regions. Bluegrass is essentially a pasture grass and can scarcely be excelled in regions where it reaches its greatest development. In Nebraska it thrives only in the eastern counties over about the same range as timothy, though it is gradually spreading westward. However, in many places lying west of the normal range it is a common constituent of pastures, and is then usually established in the more shaded situations. If there are shade trees or hedges, the bluegrass is quite certain to obtain a foothold and spread outward, holding its own very well with even the native grasses. It gives early and late pasture, but dries up in summer.

The seed should be sown very early in the spring, on the melting snow if possible, at the rate of about 25 pounds of good seed per acre. If the seed is chaffy more must be used. It is customary to sow with bluegrass a little white clover—2 or 3 pounds. The latter, however, is usually widespread in the bluegrass region and soon comes in itself.

Results at the Nebraska Station show that bluegrass furnishes considerable pasture, especially during spring and fall, as indicated in the paragraph on pastures.

Closely allied to Kentucky bluegrass is Canada or Canadian bluegrass (*Poa compressa*). This differs from the former in having a distinctly flattened stem, being of a bluish-green color, in having smaller flower clusters, and usually growing less tall. It is the com-

mon bluegrass of the New England and Northeastern States, and in some localities is called wire grass and also English bluegrass. It is adapted to somewhat more sterile soil than Kentucky bluegrass, but on the whole is scarcely to be recommended for Nebraska. The station trial of this grass was unsatisfactory.

Redtop.

Redtop (*Agrostis alba* and *A. vulgaris*) is a native of Europe and also of the northern parts of North America. In the Eastern States, especially from Pennsylvania southward, this grass is more commonly known as herd's grass. Redtop is widely cultivated and is now found growing wild through all the region indicated for timothy. Like bluegrass and white clover, it is now a common constituent of meadows and pastures even where it was not sown. It is particularly adapted to moist soils and is always recommended as a constituent of meadows or pastures on low ground. It is, however, inferior in quality to the other grasses mentioned, and also on ordinary dry ground it is inferior to them in quantity. It is to be recommended for moist meadows in the eastern part of the State and also for those localities in the sand-hills and other portions of western Nebraska where the soil is too moist for the growth of ordinary meadow grasses.

As the seed obtained in the market usually contains a large amount of chaff it is necessary to sow a correspondingly large quantity of seed. A half bushel of clean seed per acre is probably sufficient, but it may be necessary to increase this to 2 bushels if the seed is chaffy. When sown in mixtures, as is usually the case, a much less quantity may be used. A common mixture is 3 pounds of alsike clover, 4 pounds of timothy, and 4 pounds of redtop. Botanically there is a slight difference between *Agrostis alba* and *A. vulgaris*, but the seed upon the market may be of either variety. A variety known as creeping bent (*A. stolonifera*, of the seed catalogues) is often used as a lawn grass in the Eastern States. A related species, Rhode Island bent (*A. canina*), is also used as a lawn grass, but in Nebraska both these grasses are inferior to bluegrass for this purpose.

Redtop has been grown upon the Nebraska Station farm for several years and has been found to be entirely adapted to this region.

Side-oats Grama.

The first seeding of side-oats grama (*Boutelona curtipendula*), also called prairie oats and tall grama, was made in 1897. It gave the same year a yield of hay amounting to nearly two tons per acre, and the following year the product was nearly four tons per acre. The grass was partially killed during the unprecedentedly cold winter of 1899. Being a native, it is not injured by ordinarily cold weather. Seed sown in 1900 produced a good stand the first year but no crop.

During the second season, 1901, which was very dry during the late summer, the grass continued in good condition in spite of the drought, and produced a crop of seed on August 21 and a second crop October 16, after which it kept green during fall. This plot continued to give good results during 1902 (see Pl. VI, fig. 1), but as it does not form a close sod it gives a chance for various weeds to become established between the bunches. In 1903 the plot had greatly deteriorated and the grass was finally driven out by weeds.

Taking everything into consideration this is a very promising grass for the drier regions of Nebraska. It is a native of the plains and furnishes excellent forage for pasture and also promises well for hay. An important point in its favor is the fact that the plants seed abundantly and the seed is easily gathered—of good quality, and easily sown. On account of the tendency to grow in bunches it may be best to sow this with some other grass, such as brome-grass, or even with alfalfa. Much of the success in growing this grass depends upon securing good seed. In the experiment noted above, the seed was obtained from a plot previously grown upon the farm. Other plots of the same grass sown with seed obtained from the Department of Agriculture were failures on account of low vitality. The Kansas Experiment Station reports good results in the culture of this grass (Bulletin 102).

Wheat-Grasses.

Western wheat-grass (*Agropyron occidentale*) is commonly found in the western portion of the Great Plains, extending into the mountains. It propagates by stout creeping rootstocks, but does not form a close sod. In the west, from Colorado to Montana, it is called bluestem, Colorado bluestem, or Colorado grass, and it forms the bulk of the native hay of this region. It grows on bench land or bottom land, and though the yield per acre is not large it furnishes more hay than any other common grass of this region. The foliage is stiff and harsh, but the quality of the hay is good and it is readily eaten by stock.

The trials on the plots at the Nebraska station were satisfactory. Where a good stand was obtained the plant showed that it could withstand drought and produce a good crop of hay. One plot of one-fifth of an acre, sown in 1901, and on account of the poor stand resown the following year, produced on June 23, 1903, 457 pounds of hay, or at the rate of 2,485 pounds to the acre.

Wheat-grass is in fact one of the most promising of our native hay grasses. The seed is produced in abundance and is easily gathered. Experiments at stations in the arid regions have usually given good results. The rootstocks soon fill the soil and the field may require rejuvenating. This can be accomplished by disking or harrowing to cut up the rootstocks, as is often done upon the native meadows.

Although *Agropyron repens*, known as quack-grass, quitch-grass, and couch-grass, is a pestiferous weed in the Eastern States, yet for Nebraska it shows many qualities which recommend it as a hay grass. The grass is nutritious, palatable, drought resistant, and thickens up readily to form a good stand. It is true that it may tend to spread where it becomes established, but in the semiarid regions such a quality in an otherwise desirable grass would be readily overlooked. Four years' testing of this grass upon the station plots shows that it recovered easily from the drought of 1901 and formed a good growth of hay in 1902 and 1903.

Slender wheat-grass (*Agropyron tenerum*) is a native of the Northwestern States from western Nebraska to Canada and westward. This has been recognized in the region to the north of Nebraska as a valuable wild grass and has already been brought into cultivation, so that the seed can be obtained of several seedsmen in the Northwest. It resembles *A. occidentale* in many respects, but differs in the important fact that it is a bunch grass, and does not spread by creeping rootstocks. Like the other wheat-grasses, the seed habits are good, and it gives promise of meeting the requirements of a hay grass for the Northwest.

One plot at the Nebraska Station, sown in 1897, was apparently much injured by the drought of 1901, but the following spring it quickly recovered and produced a thick stand of excellent hay. Another plot, one-fifth acre in size, sown in 1901, had a similar history, but it was resown in the spring of 1902, produced a good stand, and gave a cutting of hay on July 23 of 457 pounds, or at the rate of 2285 pounds to the acre.

Grasses and Legumes of Less Importance.

Big bluestem (*Andropogon furcatus*).—This is one of the tall grasses common over the prairie region and forms, probably, the most valuable constituent of native hay produced in eastern Kansas, eastern Nebraska, and Iowa. It is usually called bluestem, or bluejoint, and is characterized by having the seed in crowfoot clusters at the top of the stem, by which it may be distinguished from the bluejoint of Colorado, which is a wheat-grass, and from the bluejoint of Minnesota, which is a grass of low grounds rather than prairies. The station plot gave rather unsatisfactory results on account of the poor stand obtained, but the bunches that were produced grew well. Although a valuable grass, the seed habits are such that it is not likely to adapt itself to cultivation. The seed is produced in small quantity, is of uncertain vitality, and the seed stalks vary so in height that it is not readily harvested.

The allied *A. scoparius*, which is another important native hay grass, called little bluestem, or, on the plains, "bunch-grass," has not been

tested at the Nebraska Station, but the above remarks concerning the seed habits apply nearly as well to this species.

Indian grass (*Andropogon nutans*).—A tall grass growing in the Eastern States and westward nearly to the mountains. It forms an important constituent of all the wild hay of the prairie regions except toward the north. It is of especial value on account of its numerous root leaves. The plot of this grass tested gave finally a luxuriant growth of foliage, although it was injured somewhat by the drought of 1901. The poor seed habits of this grass stand in the way of its cultivation. The seed is usually not very abundant and is often of low vitality.

Tall oat-grass (*Arrhenatherum elatius*).—One of the European meadow grasses which has been grown on a small scale in this country for many years. As it is a bunch grass and does not form a close sod it should not be used alone, but doubtless it will be a valuable addition to a mixture such as orchard grass and meadow fescue. It is fairly drought resistant, and has the quality of producing a comparatively rank growth the first season, for which reason it has found favor as a winter pasture grass in the South. In general, however, it seems to be better adapted to meadows than to pastures. The station plots gave a good growth of forage which produced excellent hay. One plot, one-fifth acre in size, sown in 1901 and resown in 1902, produced on June 23, 410 pounds of hay, or at the rate of 2,050 pounds to the acre. After the cutting a fine aftermath was formed. In 1903 the same plot yielded (June 16) only 310 pounds, or at the rate of 1,550 pounds to the acre, bearing out the experience elsewhere that a meadow of tall oat-grass reaches its maximum development early and then deteriorates.

Blue grama (*Bouteloua oligostachya*).—Blue grama is one of the important constituents of upland grazing regions of the Great Plains and is often called buffalo grass, but it should be distinguished from the true buffalo grass with which it is usually associated. Blue grama does not produce so large a quantity of seed and the seed is not so easily gathered or handled as side-oats grama, but ranchmen state that it is superior to this grass in nutritive qualities and palatability, and furthermore that it forms a thick sod, while the other does not. The growth is short, usually about a foot high, and hence this grass is not adapted for hay except under favorable conditions, though for pasture it is exceedingly valuable. Seed was sown on one plot in 1898 and on a second plot in 1900. The grass was slow to start from seed and the growth in the spring was slow even when the plot was established, but the stand thickened up well, and during the dry season of 1901 it was the only grass besides side-oats grama that gave sufficient growth for pasture during the period of extreme drought.

Western brome (*Bromus carinatus hookerianus*).—Three trials of this gave negative results on account of the failure of the seed to germinate, but one plot sown in the spring of 1902 with seed from the grass garden of the Department of Agriculture at Washington gave good results and showed that the grass is at least promising for the semiarid regions. Trials at stations in the Northwest have also shown that this species gives much promise. This grass is closely allied to *B. marginatus*.

Western brome (*Bromus marginatus*).—Four trials of this grass showed that it is well adapted to the conditions in Nebraska, giving a good growth and resisting the dry weather of 1901, and that it is not injured in the winter. The foliage is rather coarse and not as leafy as would be desirable, but the grass is well worth an extended trial.

Buffalo grass (*Bulbilis dactyloides*).—Buffalo grass is the common "short grass" of the Great Plains, and forms a close, thick sod by means of its numerous creeping stolons. It is entirely resistant to drought, it is very nutritious, and it cures upon the ground, thus furnishing winter feed to the range cattle. The grass forms the seed close to the ground in little nut-like clusters that are likely to escape the casual observer. The staminate or male flowers are produced in little spikes or flags, which are raised a few inches above the ground and are much more easily distinguished than are the pistillate or female flowers that produce the seed. The seed, however, is quite fertile, but is so difficult to gather that it will never be practicable to grow buffalo grass from the seed. If it is desired to produce a field of buffalo grass it should be started from the cuttings. For this purpose the sod should be cut into small pieces and planted upon prepared soil. The pieces can be dropped upon the surface of the soil and forced into the ground by stepping upon them. The distance apart depends upon the desirability of obtaining a thick stand at once. If the pieces of sod are placed 2 feet apart each way, they will thicken up between fairly well in one season. In experiments at the Nebraska Station the seed failed to germinate.

Wild rye (*Elymus canadensis*).—A common grass in many parts of the United States and extending over a large part of Nebraska, where it is found chiefly in draws and low places. It produces a large amount of hay of good quality, though rather coarse. It resists drought quite well and seems well worth an extended trial as a meadow grass. One plot on the station grounds, sown in 1901 (see Pl. VI, fig. 2), was cut on July 26, 1902, and yielded at the rate of 5,875 pounds to the acre (1,175 pounds on one-fifth acre). The same plot yielded on July 23, 1903, at the rate of 3,700 pounds per acre. The shattered seed from the plot germinated in the autumn of 1902 and produced a good stand the following season. The cutting was made after the grass had headed out, but for the best hay the cutting should

be made much before the heads appear. The form here cultivated is sometimes referred to as *E. robustus*.

Elymus virginicus.—The same remarks apply to this species as to *E. canadensis*, but this grass shows the effect of drought more quickly than that species.

Elymus virginicus submuticus.—The results with this variety are more satisfactory than with the species.

Eragrostis tenuis.—This grass has given good results in the plots, and promises well as a hay grass, although the foliage is rather wiry. The grass is a native of sandy regions of the plains, and it may prove valuable in the Sand Hills.

Wild timothy (*Muhlenbergia racemosa*).—A native grass found in moist places through the Northern States west to the Rocky Mountains. In Nebraska it is a common constituent of slough-grass hay. The results upon the station plots show that this grass can be cultivated and a fair quality of hay produced.

Japanese barnyard millet (*Panicum crus-galli*).—An annual grass of much nutritive value which gives a luxuriant growth of fodder suitable for coarse hay. The station plot of this grass, one-fifth acre, sown March 22, yielded on July 26, 1902, 1,100 pounds of hay, or at the rate of 5,500 pounds to the acre. The yield should have been much higher, but the stand was not of the best. There is no doubt that this is a good annual hay grass for portions of Nebraska which are not too dry, but as it has no especial advantage over millet and is inferior to sorghum it probably will not be used extensively. Some seedsmen have sold this under the name of Billion Dollar Grass.

Switch-grass (*Panicum virgatum*).—A bunch grass which is one of the important constituents of prairie hay in Nebraska and is well worth cultivating. The plot at the station was unsatisfactory on account of the poor stand, but the bunches present produced a good quality of hay. The grass is quite resistant to drought and produces a quantity of seed which is usually of good quality.

Reed canary grass (*Phalaris arundinacea*).—A native of marshes and sloughs through the northern tier of States. In the northern portion of the Great Plains it forms a large part of the native hay, which is generally recognized as of excellent quality. Although a native of wet soil it gives good results on comparatively dry soil. It is to be recommended for cultivation in the States from Minnesota to Washington, and south probably as far as northern Kansas, but in the southern portion of the range is adapted only to low meadows. The great disadvantage of this grass at present is the difficulty of obtaining good seed. Ordinarily the seed shatters easily at maturity. The results of the trial at the station were unsatisfactory from the fact that there was a very thin stand, which was probably due to poor seed. The common ribbon grass of gardens is a variety of this species.

Stipa robusta.—A native of the Rocky Mountain regions and the western portion of the Great Plains, where it is a common constituent of the native hay. The station plot sown in 1897 withstood the drought of 1901 and gave good crops of hay in 1902 and 1903. This grass is worthy of an extended trial.

PASTURES AND MEADOWS.

NATIVE GRASSES.

Since the native grasses and forage plants play such an important rôle in the agricultural economy of Nebraska, it will not be out of place to discuss them briefly. They have been very thoroughly studied by Dr. C. E. Bessey and other botanists of the State and for detailed information the reader is referred to articles by Dr. Bessey in the reports of the Nebraska State Board of Agriculture from 1886 to 1896, to the Phytogeography of Nebraska, by Pound and Clements, the Flora of the Sand Hills, by Rydberg, and to various articles on the grasses of Nebraska by Webber, Smith, and others.

The agricultural grasses are divided into two types, according to root formation—bunch grasses and sod formers. The bunch grasses form a crown which increases from year to year and becomes in time a raised tussock. Where bunch grasses abound there is no continuous sod but a succession of tussocks with bare soil between which supports a variety of other plants scattered here and there. Some of the common bunch grasses are bluestem, switch-grass, and Indian grass. Sod formers have rootstocks or stolons by which they spread, forming a continuous sod. Buffalo grass and Kentucky bluegrass are examples of this type.

The grasses may also be divided into those which grow tall enough to make hay, and are sometimes called "tall grasses," and the strictly grazing grasses of the western plains, called "short grasses."

Hay is made from the tall grasses which are found on all unbroken prairie of the eastern portion of the State. In the wet places or sloughs, there are various swamp grasses (chiefly slough-grass, *Spartina cynosuroides*), which, when cut young, furnish a fair, though coarse, hay. The most important hay grasses are: Little bluestem (*Andropogon scoparius* Michx.), Big bluestem (*Andropogon furcatus* Muhl.), Indian grass (*Andropogon nutans* L.), Switch-grass (*Panicum virgatum* L.), and Side-oats grama (*Bouteloua curtipendula* Michx.). These five grasses form the great bulk of the prairie hay throughout the eastern half of the State. In the western portion these grasses are confined to the river bottoms, draws, and other moist spots, and often are found in sufficient abundance for mowing. These same grasses are also used for native pasture. But in the grazing

portions of the West, except the Sand Hills, the important grasses are: Buffalo grass (*Bulbilis dactyloides* Raf.) and blue grama (*Bouteloua oligostachya* Torr.).

An important grass in the West, especially for hay, is the wheat-grass (*Agropyron occidentale*). This spreads by extensively creeping underground stems. The foliage is stiff and rather harsh, but nevertheless it forms a very nutritious hay. This grass is more resistant to drought than any of the hay grasses of the West.

There are many other grasses which are of more or less agricultural importance, but, compared with those mentioned, they are insignificant.

CARE OF NATIVE PASTURES AND MEADOWS.

Unless proper precautions are taken to prevent it, both meadows and pastures tend to deteriorate. In pastures the stock are continually eating off the most palatable plants and avoiding the others, which are in this respect weeds. To prevent such exhaustion it is necessary to limit the number of stock to the forage-producing power of the pasture. The same is true of the open range. Great harm has resulted in many instances from overstocking. Particular care must be exercised in this respect at what might be called critical periods, or when unfavorable conditions, such as drought, curtail the production of grass. In pastures this exhaustion can be avoided by supplementing the grazing by soiling crops. An excellent way to encourage the recuperative power of the native grasses is to give the pasture a rest by providing two pastures, which may be used alternately for periods of from two to four weeks.

With meadows deterioration is less marked, as the weeds are cut at the same time as the grass. However, it is advisable to allow the grasses to go to seed occasionally. It is a bad practice to pasture the aftermath during the autumn, as this encourages the growth of weeds.

The burning off of pastures or meadows is not to be recommended, as experience has demonstrated that though a green growth can be induced earlier the final results are harmful. The crowns of the grasses are injured and the fertilizing effect of the dried leaves is lost.

On the other hand, the practice of mowing the weeds in pastures in summer is good, as they are thus prevented from going to seed.

If the number of stock limited to its capacity is allowed to use the pasture, the manure thus distributed tends to keep up fertility; but meadows are constantly giving up nutriment drawn from the soil, the loss of which must in time visibly affect the capacity. Therefore, wherever the value of the hay is a sufficient recompense, it is well to supply barnyard manure to make up this loss.

TAME PASTURES AT THE NEBRASKA EXPERIMENT STATION.

A field of 30 acres was sown in April, 1899, with a mixture of 2 pounds each of orchard grass, timothy, bluegrass, tall oat-grass perennial rye-grass, and white clover, 4 pounds of red clover, and 1 pound of alsike. Three pounds of alfalfa were added to 5 acres of this mixture. In 1900, 30 tons of hay were cut and excellent pasture was obtained through the fall. In 1901, the pasture was in excellent condition, supporting 25 to 35 head of cattle and giving 14 tons of fine hay. This pasture has been top-dressed with barnyard manure about every other winter, and during the summer the weeds have been mown two or three times. In the spring of 1900 the field was disked and sown with brome-grass and meadow fescue. These grasses have gradually gained the ascendency until now the alfalfa has disappeared and there is little to be seen besides the grasses mentioned.

This tendency for certain grasses to predominate in a mixture is shown by the history of a 30-acre field of native pasture. About 1887 a portion of this pasture on the south side was sown with bluegrass and white clover. The bluegrass has gradually spread over the whole field, and at present the pasture appears to be mostly bluegrass, which is especially in evidence during early spring and late fall, while during the summer, particularly if the season is dry, the native grasses are conspicuous. This is the usual tendency where bluegrass is able to thrive. It holds its own with other cultivated grasses, and may even crowd out its competitors; but when combined with native grasses, these are able to hold their own in the prairie region of the State. The bluegrass starts to grow much earlier than the native grasses and gives in early spring an excellent quality of pasture. In the dry part of the summer the bluegrass dries up and becomes dormant while the native grasses continue to vegetate. In the autumn as the weather becomes cooler the bluegrass again starts up and gives late pasture. The experimental pasture had been top-dressed with barnyard manure about every third winter, and during the summer the weeds were mowed two or three times. In 1898, 4 acres of the above fields were plowed and sown to brome-grass. In the spring of 1901, 3 acres of alfalfa were added from an adjoining field. This portion was disked the following spring and sown with brome-grass and meadow fescue. These grasses have driven out the alfalfa, and now none of the latter can be found in the field. During the season of 1903 this field carried 40 head of cattle all summer, and also yielded a crop of hay estimated at one-fourth ton per acre.

Another field sown with timothy, orchard grass, bluegrass, meadow fescue, and brome-grass is now nearly all brome-grass.

THE SEED BED FOR GRASSES AND CLOVERS.

The ideal seed bed for grasses and clovers is a firm but friable lower soil, with loose, well-tilled top soil. To produce this condition requires careful tillage for several years preceding the sowing. The soil should contain sufficient moisture to insure the young plants a good start in case there should be a deficient rainfall after sowing. Seed sown on a dry soil may receive sufficient rainfall to germinate, but not enough to supply the young plants with the necessary moisture. Careful preparation of the seed bed is more essential in seeding grasses than in seeding almost any other crop, and failure to obtain a stand entails a greater loss. Land that has been planted to a cultivated crop, for which the soil has been well tilled and which has received clean and level cultivation, may in most cases be well fitted for seeding grasses by disking and harrowing without plowing, provided the trash be removed. When disking the disk should always be lapped one-half on each round, thus covering the field twice, and generally it is well to go over the field a second time at right angles to the first disking. A smoothing harrow should follow the disk. Well-cultivated land has these advantages: The weeds have been exterminated, the moisture has been conserved, and the top soil is in good tilth. Fall plowing is desirable on land that settles well through the winter and that does not blow badly, but there is much soil on which fall plowing can not be done advantageously when spring seeding is intended. In any case as long a period as possible should elapse between plowing and seeding, but during that time the top soil should be kept loose and clean with the disk or drag. During this period the soil settles, the large spaces are filled, and the moisture is diffused through the plowed soil. Disking the soil before plowing is advisable, as it cuts up the trash if there is any, and pulverizes the soil turned under so that it settles more quickly. The use of the subsurface packer or the disk set straight and run in the direction of the furrow also helps greatly to firm the soil. The use of either of these implements should follow the plow by the least possible number of hours. Stubble land for fall seeding may in some cases best be plowed and in others disked, depending on a great variety of circumstances, but in any case the sooner the soil is prepared after cutting the grain the better, and it is imperative that the surface be kept stirred and clean up to the time of seeding.

ANNUAL FORAGE CROPS.

Sorghum.

Sorghum (*Andropogon sorghum*) is one of the most important annual forage grasses of the United States. It is grown throughout the South and well to the west on the Great Plains. It resists drought better

than any other succulent forage crop and gives large yields of excellent hay. Sorghum may be used for soiling and for pasture, but its most important use is for cured fodder or hay. For this purpose it may be sown thickly and mowed with a mowing machine. The hay is succulent and requires some time for curing, but in the drier portions of Nebraska it can be thrown into bunches or cocks and allowed to remain until cured.

Kafir corn, a variety of nonsaccharine sorghum, is also quite drought resistant and is frequently grown for forage, but under the same conditions the sorghum gives a greater yield of fodder. Sorghum can also be planted in rows and cultivated. The forage can then be gathered by cutting and shocking, preferably with a corn harvester. The ordinary sugar sorghums, such as Early Amber, Colman, and Orange, are used for this region. Sorghum is frequently referred to as "cane."

Other races of sorghum are milo maize, Jerusalem corn, and dhoura, but in Nebraska none of these is equal to sorghum for fodder.

Sorghum was tested in the series of pasture tests already mentioned (Bulletin 69 of the Nebraska Experiment Station), as were also white Kafir corn and milo maize. One-fifth acre of sorghum gave twenty-five days' pasturage and was, along with rye, one of the crops giving the greatest quantity of forage. Some experiments were also tried with sorghum for soiling, which indicated that the quantity of forage thus obtained was two to three and one-half times as much as when the crop was pastured.

The possible injurious effects of pasturing sorghum have already been alluded to in another paragraph. (See also Bulletin 77 of the Nebraska Experiment Station.)

An acre of Early Amber sorghum, drilled with a corn planter in double rows, 6 inches between rows, 3 feet apart, June 12, was cut on September 19 with a corn binder and shocked in the field. The weight of this, taken December 1, was 8,715 pounds.

A similar plot was treated in the same manner, except that the seed was planted with a grain drill in rows 8 inches apart. The forage was cut the same as the other plot but with a mowing machine, and was put in cocks, where it remained till December 1. The weight was then found to be 12,350 pounds, or over 6 tons per acre.

In the drier portions of the State where it is necessary to conserve the moisture, it is advisable to plant the seed in rows in order to admit of cultivation. The crop is thus made more certain.

Millet.

Common millet (*Setaria italica*) is much grown in eastern Nebraska as a summer hay crop and frequently as a catch crop after grain. It can be cut in about two months from the time it is planted, and is an

excellent hay plant. It should be cut between the time of heading out and that of late bloom, for if cut too early the hay is too laxative in its effect and if cut too late the seed has injurious effects, especially upon horses. The hay is succulent and requires more time to cure than does timothy. About one-half bushel of seed per acre is used. Different varieties are called Hungarian grass, German millet, Siberian millet, etc.

In the pasturing tests (see Bulletin 69 of the Nebraska Experiment Station) millet gave eighteen and a half days' pasturage for one cow and was available at the same time as sorghum, Kafir corn, and cowpeas. "It did not have as favorable an effect upon the milk flow or butter fat production as did any of these crops or as did the mixed grasses."

Broom-corn millet (*Panicum miliaceum*) is a different species, sometimes called hog millet. This gives good results in the Dakotas and other Northern States and also promises well for Nebraska. In 1903, a one-half acre plot of Red Orenburg (S. P. I. 9423) sown June 12 and cut August 15 yielded at the rate of 3,250 pounds of hay to the acre.

Cowpea.

Cowpea (*Vigna catjang*) is an annual legume which has been grown in oriental countries for an indefinite period. It is now one of the standard forage plants of the South, being extensively cultivated as an annual summer crop for hay, pasture, and green manure. During recent years its range has been steadily pushed northward, until now it is grown with more or less success as far north as Wisconsin and New York. There are a large number of varieties, differing greatly in their method of growth, time necessary to reach maturity, hardiness, and many other characters that affect the adaptability to conditions.

Although one of the standard hay plants of the South, it is not adapted for hay in Nebraska. It is difficult to cure and can not compete with alfalfa and clover. It is an excellent soiling plant, but under present conditions of agriculture it is not likely to be needed for this purpose in Nebraska in the near future, except possibly on a small scale in dairy districts. It is not well adapted for silage on account of its succulence, but has been used in this way when mixed with other plants. (See Circular 24 of the Division of Agrostology, U. S. Department of Agriculture.)

The chief field of usefulness of the cowpea in Nebraska is for pasture during the autumn. The seed must be sown when the ground is well warmed, which in Nebraska may not be until June. Although late varieties, which produce no pods in this State, can be utilized for forage, yet the plant gives best returns when the pods are forming. Hence, those varieties should be grown which mature at least a part of the seed before frost. This is especially advisable, because of the high price of seed. Where adaptability to climate is so important as in the

case of the cowpea, growers should endeavor to use home-grown seed, which always aids in such adaptation. For pasture the cowpea is well adapted to cattle, sheep, and, especially when the pods are ripening, to hogs. Poultry readily eat the seeds.

The pasture tests of 1900 (see Bulletin No. 69 of the Nebraska Experimental Station) showed that one-fifth acre furnished twenty days' pasture—July 24 to August 13. There was a highly favorable effect upon the milk flow and the butter fat produced, in which respect "the forage far surpassed all of the other crops except alfalfa, and was even slightly superior to that very valuable forage plant." In this test the variety used was the Whip-poor-will.

Two plots of the above variety were sown in 1897 to test the yield of fodder. They were harvested on September 23 and gave at the rate of 4.37 tons and 4.62 tons to the acre. A plot grown in 1896 gave a yield of green fodder amounting to 22,850 pounds per acre, or something over two tons of hay.

Small Grains.

For late fall and early spring pasture nothing excels the winter grains in palatability, nutritive qualities, and in quantity of forage. It is customary to utilize winter wheat incidentally for pasture at such seasons of the year in localities where this crop is grown for grain. Rye is frequently used for pasture, and this plant is to be highly recommended wherever it can be grown as a winter crop. The grains can also be used to advantage as a spring crop, but in this case the pasturage comes later in the season when the want is less keenly felt. Rye sown in the autumn produces pasture at a season when permanent pastures are dormant or giving only meager returns.

In the pasturing tests, a one-fifth-acre plot gave about twenty-seven days' pasturage. "It furnished the earliest pasturage of any of the annual forage crops and could have been pastured in the fall."

The small grains make an excellent quality of hay and in Nebraska are not infrequently used for this purpose. In California the great bulk of the hay upon the city markets is grain hay made from wheat and oats.

Oats and rye are also used in Nebraska as soiling crops during spring and early summer. Although the amount used by each farmer in this way may be small, yet the aggregate must be considerable.

Corn.

This is by far the most valuable plant grown in Nebraska, as it is also of the United States. It is grown chiefly for the grain, but in this bulletin we are concerned with its forage value. Where corn is grown for the grain there are two common methods of utilizing the stalks. The corn may be allowed to mature in the field and the ears husked

from the standing stalks during the autumn, or as soon as convenient. After the ears have been harvested, the remaining stalks are utilized by turning cattle, sheep, or horses upon them to secure what they can from the waste grain and the dry fodder. The nutritive value of such fodder is slight, especially during the winter. The second method of harvesting corn is to cut the stalks a short time before the grain is mature and while the foliage is still green. The stalks are placed in shocks to cure, after which the ears are husked out and the remaining stalks may be reshocked, or placed in stacks or barns, and constitute what is usually known as corn fodder or, more properly, corn stover. Properly cured corn stover is quite nutritious and compares favorably with hay. When the fodder is shredded a greater proportion is utilized. There is considerable deterioration in the nutritive value of stover during storage in the field or even in barns.

The value of corn grown for hay should not be underestimated. When planted thickly so that the ears are reduced to one-half or one-fourth the normal size and the stalks cut earlier than when grown for grain, the fodder is large in quantity and very excellent in quality. Besides its value for hay, corn is one of the best plants for silage or ensilage and for a soiling crop.

The pasturing tests at the Nebraska Station show that one-fifth acre plot gave eighteen and one-half days' pasturage for one cow, but though "It may be of value to furnish feed between the periods of rye and sorghum pasturage, it is not equal to either of these."

Soy Bean.

Soy bean (*Glycine hispida*)[a] is a leguminous plant grown for forage and for grain. For forage it is much used in the Middle South, but has not thus far given much promise for this purpose in Nebraska. For seed or grain it has given fairly good results in Kansas. (See Bulletin No. 100 of the Kansas Experiment Station.) In that State the Early Yellow variety has given the best returns. There is some difficulty in harvesting the crop, as a special harvester is required if the beans are raised on a large scale.

Soy beans (American coffee berry) were tested in 1898 to determine their value as summer feed, but the results were not sufficiently satisfactory to warrant the continuance of the experiment. (See Bulletin 69 of the Nebraska Experiment Station.) In 1896 a plot of soy beans yielded at the rate of 15,000 pounds of green fodder per acre.

Several varieties have been grown at the Nebraska Station to test their seed production, but the results were not satisfactory, as none gave a sufficiently high yield to be profitable for this purpose.

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[a] For a full account, see Farmers' Bulletin No. 58, United States Department of Agriculture.

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Rape.

Rape (*Brassica napus*) is a succulent plant, resembling the turnip, which is used for pasture in the cooler parts of the United States. It has been grown upon the station farm and is to be recommended for fall pasture for hogs and sheep. It is also useful for calves and growing cattle, but there is much loss from the trampling of the larger stock. The milk is likely to be tainted when rape is fed to cows, although this may be avoided by feeding (soiling) just after milking. The chief value of rape in Nebraska, however, is as fall pasture for hogs and sheep. It gives succulent feed until frost or even somewhat later. A succession of pasture may be produced by planting the seed at different dates. It is ready to use about ten weeks after planting. For further information as to rape see Farmers' Bulletin No. 164, United States Department of Agriculture.

Canada Field Pea.

Canada field pea (*Pisum arvense*), a legume, resembling the garden pea, has proved very successful in Canada and the cooler parts of the United States. It is adapted to a cool, moist climate, though it can be grown with some success in the Middle South as a winter crop. It is usually sown with grain, especially oats, the grain serving to hold up the peas, the combination being very satisfactory for forage. The peas and oats are usually made into hay, although they may be used for pasture or soiling.

Experiments were tried at the station in the pasture tests. (See Bulletin 69 of the Nebraska Experiment Station.) One-fifth acre plot of oats and peas gave twenty-one and one-half days' pasturage, which was available in June, somewhat later than rye. Although peas can be used in this way in moist years, the conclusion was reached that Nebraska is too far south for the best results with this crop.

Vetch.

Hairy vetch (*Vicia villosa*) is an annual legume more drought resistant than the common vetch and better adapted to sandy soils, for which reason it is sometimes called sand vetch. It has proved very successful in eastern Washington and is much used as a winter crop in the Middle South. It gives the best results when combined with grain. Although it can be grown in eastern Nebraska, experiments show that the forage produced is inferior in quantity, and that it can not compete with other legumes.

Spring vetch (*Vicia sativa*) is not suited to Nebraska, as it requires a cool, moist climate. Winter vetch (*Lathyrus hirsutus*) is not to be recommended for that region.

PLANTS WHICH CAN NOT BE RECOMMENDED.

The following grasses and forage plants have been tested, but the results are not such that they can be recommended for Nebraska. Some of the trials were failures because the seed did not germinate. In such cases judgment upon the value of these plants must be reserved. The experiments were based upon trials extending, in many cases, over as many as six years:

Agropyron caninum.—The tests with this wheat-grass were unsatisfactory on account of a mixture of seed, but it showed no evidence of value.

Agropyron divergens.—There was no stand produced with this grass, but experiments at other stations in the Northwest, notably at Pullman, Wash., have shown that it can be grown successfully from the seed and is well adapted to the semiarid conditions of that region. Although with seed of good vitality it may prove successful here, it probably has no advantage over *Agropyron occidentale*. *Agropyron divergens inermis* was also tried, but it produced a poor stand and was not promising.

Agropyron violaceum.—Several trials were made, but the results were unsatisfactory.

Johnson grass (*Andropogon halepensis*).—A common and valuable hay grass for the Southern States, but it has shown itself to be a difficult plant to eradicate, and hence has become in many sections a great pest. In Nebraska it will not usually survive the winter. This grass was sown at the station in the spring of 1897 and survived the winter of 1897–98, but it was killed out during the next winter. Other attempts to raise it resulted in continual loss during the winter.

Sweet vernal grass (*Anthoxanthum odoratum*).—This grass has little forage value anywhere, but it is sometimes used in the Eastern States to impart a pleasing odor to the hay, for which purpose a small quantity suffices.

Australian saltbush (*Atriplex semibaccata*).—This forage plant has proved quite successful in California and in some other parts of the Southwest, especially in alkali soil. However, in States as far north as Nebraska it is unable to survive the winters, and hence must be grown as an annual, but the uncertainty of germination and the rather meager growth the first season render it unsatisfactory as an annual forage plant. The trial at the station extended over four years, but in no case were the results at all promising. The plants were killed out every winter except in 1900–1901. Even the second year's growth was too small to be of much value.

Swamp-chess (*Bromus ciliatus*).—The plots gave a fairly good stand, but the plants do not thicken up in the plot, and the individuals are coarse and not leafy enough for hay. Although this grass might be

grown for hay, it shows nothing to recommend it to favor compared with other grasses better adapted to the purpose.

Rescue grass (*Bromus unioloides*).—A fairly good grass, but it will not endure the winters in Nebraska.

Bluejoint (*Calamagrostis canadensis*).—This is a common prairie grass of the Northern States, extending west into eastern Nebraska. In Minnesota and Iowa it is a valuable wild hay grass and there called bluejoint (not to be confused with the bluestem of Nebraska, *Andropogon furcatus*, nor the bluestem of the foot hills, *Agropyron occidentale*). It thrives particularly on moist prairie and swales. Attempts to grow this grass from seed have usually been unsuccessful, as the seed seems to lack vitality. At the Nebraska Station the seed produced a very poor stand.

Bermuda grass (*Cynodon dactylon*).—The best grass for summer pasture in the South, but not hardy in Nebraska.

Crested dog's-tail grass (*Cynosurus cristatus*).—No improvement over Nebraska grasses and not to be recommended.

Florida beggar-weed (*Desmodium molle*).—An annual leguminous plant of Florida and the West Indies, where it is frequently used for forage. It can be grown throughout the Southern States and even as far north as Nebraska. For the latter State, however, it is not likely to be grown extensively, as it does not meet the requirements so well as other plants. On the station plots this made quite a heavy growth of woody, unpalatable forage.

Elymus glabriflorus and *Elymus glaucifolius*.—A poor stand was obtained of both these grasses, but they should be tested further.

Eriocoma cuspidata.—A common range grass in the Rocky Mountain region, but it does not give promise under cultivation.

Eriochloa punctata.—A promising grass for the South, but scarcely able to endure the winters of Nebraska.

Teosinte (*Euchlæna mexicana*).—A tropical annual forage plant which is often grown in the rich bottom lands of the Southern States and is frequently advertised by seedsmen for the North. It produces under favorable conditions a large quantity of forage, but in Nebraska it is far inferior to sorghum for this purpose. It is a coarse grass, resembling corn.

Eurotia lanata.—This is not a grass, but a forage plant, well known under the name of "winter fat." In the Western States, where it furnishes excellent feed upon the range, attempts to cultivate it have not been attended with much success. Seed planted at the Nebraska Station failed to germinate.

Horse bean (*Faba vulgaris*).—The common field bean of Europe, where it is a staple forage plant; but in this country it has not given satisfactory results.

Tall fescue (*Festuca elatior*).—Results unsatisfactory and plot finally discarded.

Reed fescue (*Festuca elatior arundinacea*).—A tall form of *Festuca elatior*, which gives good results in the Eastern States, but is much inferior in Nebraska to *Festuca pratensis*, the meadow fescue.

Sheep's fescue (*Festuca ovina.*)—A bunch grass of low growth, cultivated in Europe and recommended frequently for the northern portion of the United States. It is not suited for hay, but is of some value for pasture in mountain regions and in the cooler parts of the country, especially in mixtures for sterile soil. But it appears to be entirely unsuited to conditions in Nebraska. Several varieties or related species of this grass (*Festuca sulcata*, *Festuca duriuscula*, *Festuca rubra*) have been tried at the Nebraska Station, but none is to be recommended.

Curly mesquit (*Hilaria cenchroides*).—The common upland grass upon the plains of Texas, where it replaces buffalo grass, which it much resembles in appearance. The plots gave only a thin stand. This species is not hardy as far north as Nebraska.

Velvet grass (*Holcus lanatus*).—A native of Europe and cultivated occasionally in this country, especially in the Puget Sound region, where it is also now growing without cultivation. It has little to recommend it anywhere, and is certainly not worthy of cultivation in Nebraska.

Hordeum bulbosum.—This grass gave a fair stand, but seems not well adapted to the climate, being injured by cold winters.

Wild barley (*Hordeum nodosum*).—Growth not sufficiently rank for a forage grass.

Koeleria cristata.—A common native grass upon the prairies throughout Nebraska. It is a small, slender perennial, flowering in June and not sufficiently rank in its growth to warrant cultivation. The plot of this grass gave a fair early growth, but disappeared the latter part of the summer.

Winter vetch (*Lathyrus hirsutus*).—This vetch has not been tried at the Nebraska Station, as it is unsuited to the climate.

Bitter vetch (*Lathyrus sativus*).—A good stand was obtained, but the climate is entirely too hot and dry in Nebraska for this legume.

Flat pea (*Lathyrus sylvestris wagneri*).—A strong growing perennial which has given excellent results at several experiment stations in the arid regions. The plant seems to be very resistant to drought, but those who have tried it report that it is not palatable to stock and that they have been unable to utilize it as a forage plant.

Leptochloa dubia.—A grass of the Southwestern States which is not adapted to the Nebraska climate.

Japan clover (*Lespedeza striata*).—An annual legume, but not resembling clover very closely. It is frequently grown in the Southern States but is not hardy in Nebraska.

Perennial rye-grass, *English rye-grass* (*Lolium perenne*).—A well-known cultivated grass in England and other European countries. In

the United States it has been cultivated for many years. On the station plot there was a good stand produced, but the grass was soon run out by other plants.

The Italian rye-grass (*Lolium italicum*) was not tried at the station, but its characters are similar to those of perennial rye-grass. Both are short-lived perennials and are not well suited to permanent pasture. Where the climate is adapted to their growth, they have the advantage of giving an abundant early growth, for which reason they are to be recommended for mixtures, as they give a luxuriant growth the first season and then give way to the other grasses. The climate of Nebraska is too dry for successful results with these grasses.

Lupines (*Lupinus spp.*).—None of the lupines has given satisfactory results in America.

Bur clover (*Medicago denticulata*).—An annual clover, frequently grown for winter forage in the Southern States, but not suited to Nebraska conditions. The station plot produced a thin stand and unsatisfactory growth.

Melica altissima.—A fair stand was obtained, but it soon disappeared.

White sweet clover or *Bokhara clover* (*Melilotus albus*).—An excellent legume for renovating clay lands, and fairly drought resistant. The great objection to its use as a forage plant in the West has been the fact that stock will not eat the plant. However, it is not infrequently reported that it has been fed to stock with success. The foliage contains a bitter substance which is disagreeble to animals, and it seems necessary that the taste for the plant be acquired. It is reported by some that if stock are turned into a field early in the spring such a taste is easily acquired. The plant has not been sufficiently tested in Nebraska. Besides its possible forage value it is an excellent bee plant.

Velvet bean (*Mucuna utilis*).—An annual legume which forms long trailing vines, and is much used in Florida for a green fertilizer and as a forage plant. It has been recommended for growing much farther north; but though it produces a good growth of vine it is less valuable than the cowpea for the same purpose. This has not been tested at the Nebraska Station.

Sainfoin (*Onobrychis sativa*).—A legume cultivated in Europe and advertised by most seedsmen in this country. The results of the trials in Nebraska are too unsatisfactory to recommend it for use in that State. In fact, there has been little success with this plant anywhere in this country.

Panicum bulbosum.—A native hay grass of Texas, and quite promising for cultivation in the Southwest, but Nebraska is evidently too far north for its successful growth.

Pearl millet or *pencilaria* (*Pennisetum spicatum*).—A coarse annual forage plant, resembling sorghum. Some extravagant claims have been made for this plant, but though it has much to recommend it in the Southern States, in Nebraska it is inferior to sorghum. At the station, in 1903, it made a large growth of forage, but it was not of great food value. For a full account of pearl millet the reader is referred to Farmers' Bulletin No. 168, U. S. Department of Agriculture.

Poa lævigata.—Three years' trials show that this grass would be excellent for pasture, but does not grow tall enough for hay. It showed great drought resistance during the dry period in 1901.

Sacaline (*Polygonum sachalinense*).—This plant, which resembles a large smartweed, has been occasionally advertised by seedsmen, but it has no value as a forage plant in Nebraska.

Burnet (*Poterium sanguisorba*).—A plant belonging to the rose family and used in Europe for pasture, for which purpose it has been recommended in this country. The trials at the Nebraska Station show that the plant gave a fair stand and is able to resist the winter, and also seems fairly drought resistant. Nevertheless, its good qualities are not sufficiently marked to warrant its being recommended for Nebraska. The trials at other stations have resulted much the same. For ordinary pasture purposes the growth is not sufficiently rank nor is the foliage as palatable to cattle as are the grasses. It may have a place as a constituent in sheep pasture upon sterile sandy or rocky soil in the Northeastern States, but in Nebraska it is not likely to be of much value.

Slough-grass (*Spartina cynosuroides*).—A native grass, common in sloughs and marshes, that furnishes considerable coarse hay when mowed early. The grass is commonly used for thatching sheds and for topping haystacks. In the trials at the Nebraska Station the seed failed to germinate.

Giant spurry (*Spergula maxima*).—This annual plant has some value for forage upon sandy land, but it is scarcely drought resistant enough for Nebraska.

Sporobolus cryptandrus.—A grass especially adapted to sandy soils, and one of the common native grasses of the Sand Hill region. It furnishes valuable grazing when young, but becomes dry and coarse by middle summer. At the Nebraska Station the seed did not germinate.

Saccaton (*Sporobolus wrightii*).—An important native forage grass of the Southwest, but not hardy as far north as Nebraska. There was no germination on the station plot.

Crimson clover (*Trifolium incarnatum*).—An excellent annual clover for the middle South, but not hardy in Nebraska.

The following plants were sown, but gave negative results, because the seed failed to germinate or gave only a thin or scattering stand:

Agropyron dasystachyum.
Agropyron dasystachyum subvillosum.
Agropyron riparium.
Agropyron vaseyi.
Agrostis exarata.
Alopecurus occidentalis.
Atriplex holocarpa.
Atriplex nuttalli.
Atriplex pabularis.
Beckmannia erucaeformis.
Bouteloua polystachya.
Bromus kalmi.
Bromus vulgaris.
Bromus richardsoni.
Bromus richardsoni pallidus.
Calamagrostis hyperborea americana.
Dactyloctenium australense.
Deschampsia cæspitosa.
Eleusine coracana.
Elymus ambiguus.
Elymus condensatus.
Elymus glaucus.
Elymus macouni.
Elymus simplex.
Muhlenbergia gracilis.
Panicularia americana.
Panicularia nervata.
Panicum obtusum.
Phleum alpinum.
Poa fendleriana.
Poa læviculmis.
Poa lucida.
Poa macrantha.
Poa nevadensis.
Poa pratensis var. (Washington bluegrass.)
Poa wheeleri.
Polypogon monspeliense.
Puccinellia airoides.
Triodia mutica.
Trifolium involucratum.

INDEX OF GRASSES AND FORAGE PLANTS.

PLATES.

DESCRIPTION OF PLATES.

PLATE I. *Frontispiece.* Grass garden at the Nebraska Experiment Station. The forage plants are first tested on these plots, which are 3 feet square. Those which give favorable results are given a further trial on larger plots, some of which are seen in the background.

PLATE II. An alfalfa plant from seed sown August 19, 1902, and dug up April 13, 1903, showing the tubercles upon its roots by means of which nitrogen is gathered from the air.

PLATE III. Fig. 1.—Three plants of brome-grass (*Bromus inermis*) from seed sown August 19, September 19, and October 1, 1902, respectively. They were taken up and photographed April 13, 1903. The plant at the right from the last sowing had barely enough vitality to survive the winter. Fig. 2.—Three alfalfa plants from seed sown at the same date as the brome-grass, and also taken up and photographed April 13, 1903. A later sowing, October 21, was almost entirely winter killed, as the young plants had not sufficient vitality to withstand the cold.

PLATE IV. Fig. 1.—Plots of *Bromus inermis* showing the effect of fertilizers. The plot at the left is a mixture of brome-grass and alfalfa; the plot at the right is brome-grass fertilized with sodium nitrate; the plot in the center is brome-grass alone and unfertilized. The effect of an admixture of alfalfa is about the same as an application of sodium nitrate. This seems to indicate that the brome-grass is able to share with the alfalfa the nitrogen which the latter obtains from the air. The plots were sown April 21, 1899, and photographed June 12, 1903. Fig. 2.—A pasture containing orchard grass, showing the growth of this grass upon low land. The pasture was seeded in 1898 with several grasses, among which was orchard grass, but in this part of the field the latter was especially rank. The photograph was taken in June, 1901.

PLATE V. Fig 1.—A field of brome-grass sown in the spring of 1898 and broken in the fall of 1901. The picture was taken in January, 1902. Brome-grass forms a thick, firm sod, resembling that of native prairie. Fig. 2.—A field of brome-grass. The seed was sown in the spring of 1902, and the picture was taken June 15, 1903.

PLATE VI. Fig. 1.—A field of side-oats grama (*Bouteloua curtipendula*) just before ripening. The seed was sown in the spring of 1900, and the photograph taken July 17, 1902. Fig. 2.—A field of wild rye (*Elymus canadensis*). The seed was sown in the spring of 1901, and the photograph taken July 17, 1902.

ALFALFA, SHOWING NITROGEN-GATHERING TUBERCLES.

FIG. 1.—BROME-GRASS PLANTED IN THE AUTUMN.

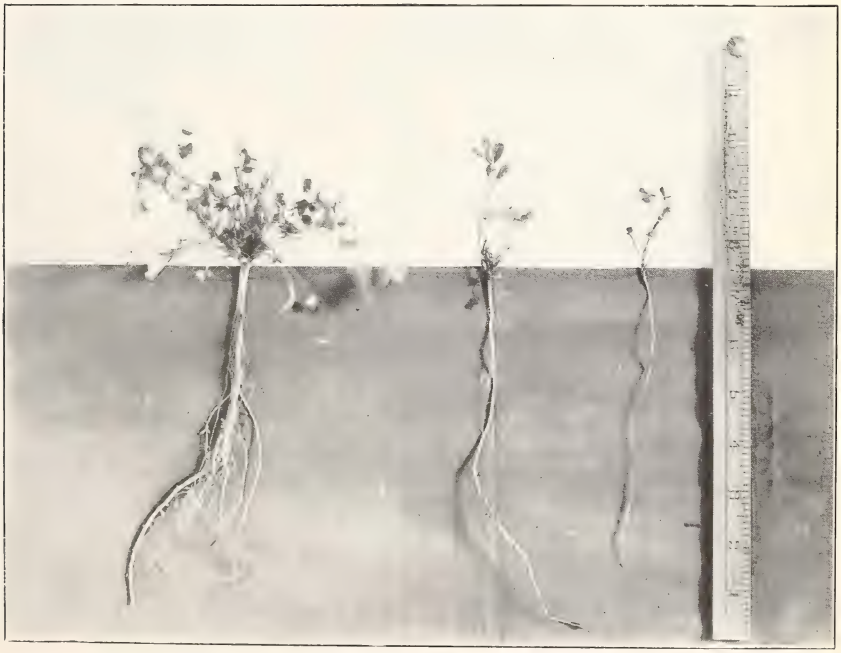

FIG 2.—ALFALFA PLANTED IN THE AUTUMN.

FIG. 1.—BROME-GRASS, FERTILIZED AND UNFERTILIZED.

FIG. 2.—FIELD OF ORCHARD GRASS.

FIG. 1.—BROME-GRASS. NEWLY TURNED SOD.

FIG. 2.—BROME-GRASS. A HAY FIELD.

FIG. 1.—SIDE-OATS GRAMA, GROWN FROM SEED.

FIG. 2.—ELYMUS CANADENSIS, GROWN FROM SEED.

[Continued from page 2 of cover.]

25. Miscellaneous Papers: I. The Seeds of Rescue Grass and Chess. II. Saragolla Wheat. III. Plant Introduction Notes from South Africa. IV. Congressional Seed and Plant Distribution Circulars, 1902–1903. 1903. Price, 15 cents.
26. Spanish Almonds and Their Introduction into America. 1902. Price, 15 cents.
27. Letters on Agriculture in the West Indies, Spain, and the Orient. 1902. Price, 15 cents.
28. The Mango in Porto Rico. 1903. Price, 15 cents.
29. The Effect of Black Rot on Turnips. 1903. Price, 15 cents.
30. Budding the Pecan. 1902. Price, 10 cents.
31. Cultivated Forage Crops of the Northwestern States. 1902. Price, 10 cents.
32. A Disease of the White Ash Caused by Polyporus Fraxinophilus. 1903. Price, 10 cents.
33. North American Species of Leptochloa. 1903. Price, 15 cents.
34. Silkworm Food Plants. 1903. Price, 15 cents.
35. Recent Foreign Explorations, as Bearing on the Agricultural Development of the Southern States. 1903. Price, 15 cents.
36. The "Bluing" and the "Red Rot" of the Western Yellow Pine, with Special Reference to the Black Hills Forest Reserve. 1903. Price, 30 cents.
37. Formation of the Spores in the Sporangia of Rhizopus Nigricans and of Phycomyces Nitens. 1903. Price, 15 cents.
38. Forage Conditions and Problems in Eastern Washington, Eastern Oregon, etc. 1903. Price, 15 cents.
39. The Propagation of the Easter Lily from Seed. 1903. Price, 10 cents.
40. Cold Storage, with Special Reference to the Pear and Peach. 1903. Price, 15 cents.
41. The Commercial Grading of Corn. 1903. Price, 10 cents.
42. Three New Plant Introductions from Japan. Price, 10 cents.
43. Japanese Bamboos and Their Introduction into America. 1903. Price, 10 cents.
44. The Bitter Rot of Apples. 1903. Price, 15 cents.
45. The Physiological Rôle of Mineral Nutrients in Plants. Price, 5 cents.
46. The Propagation of Tropical Fruit Trees and Other Plants. Price, 10 cents.
47. The Description of Wheat Varieties. 1903. Price, 10 cents.
48. The Apple in Cold Storage. 1903. Price, 15 cents.
49. The Culture of the Central American Rubber Tree. 1903. Price, 25 cents.
50. Wild Rice: Its Uses and Propagation. 1903. Price, 10 cents.
51. Miscellaneous Papers: Part I. The Wilt Disease of Tobacco and its Control. 1903. Price, 5 cents. Part II. The Work of the Community Demonstration Farm at Terrell, Tex. Price, 5 cents.
52. Wither-Tip and Other Diseases of Citrous Trees and Fruits Caused by Colletotrichum Glœosporioides. 1904. Price, 15 cents.
53. The Date Palm and its Utilization in the Southwestern States. [In press.]
54. Persian Gulf Dates and Their Introduction into America. 1903. Price, 10 cents.
55. The Dry Rot of Potatoes Due to Fusarium Oxysporum. 1904. Price, 10 cents.
56. Nomenclature of the Apple. [In press.]
57. Methods Used for Controlling and Reclaiming Sand Dunes. 1904. Price, 10 cents.
58. The Vitality and Germination of Seeds. [In press.]